United States Department of Agriculture

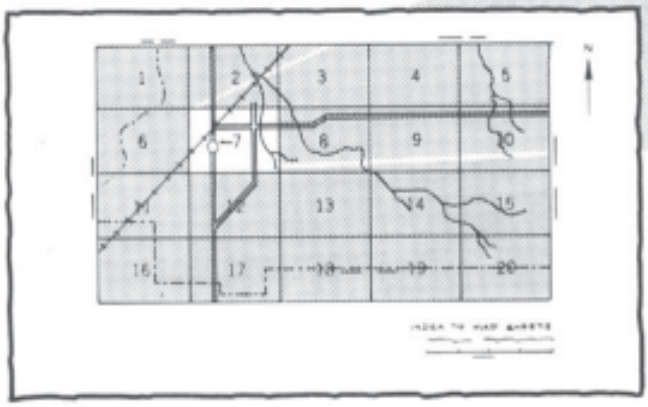
Soil Conservation Service

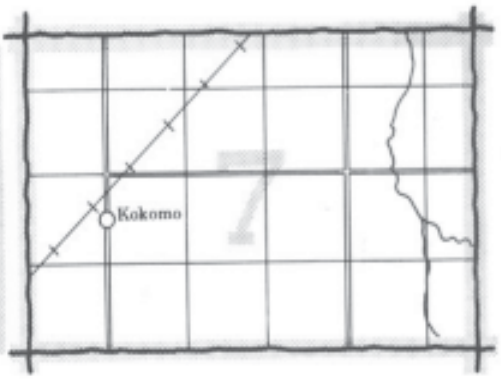
In cooperation with the Minnesota Agricultural Experiment Station

Soil Survey of Brown County, Minnesota

HOW TO USE

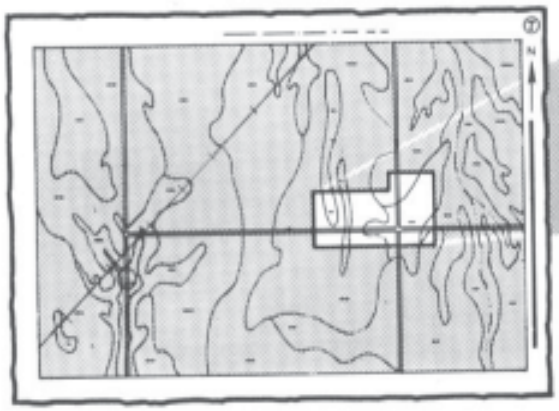
1. Locate your area of interest on the "Index to Map Sheets"

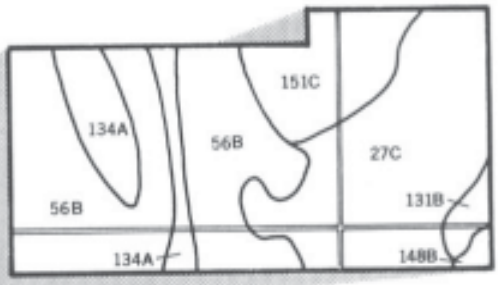




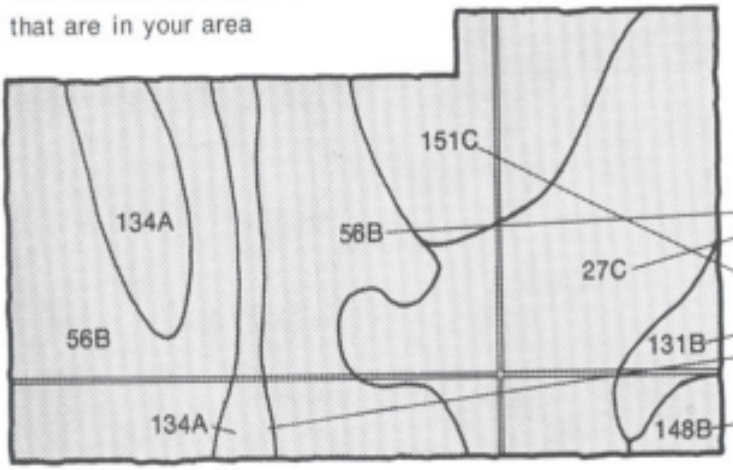
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.





4. List the map unit symbols that are in your area

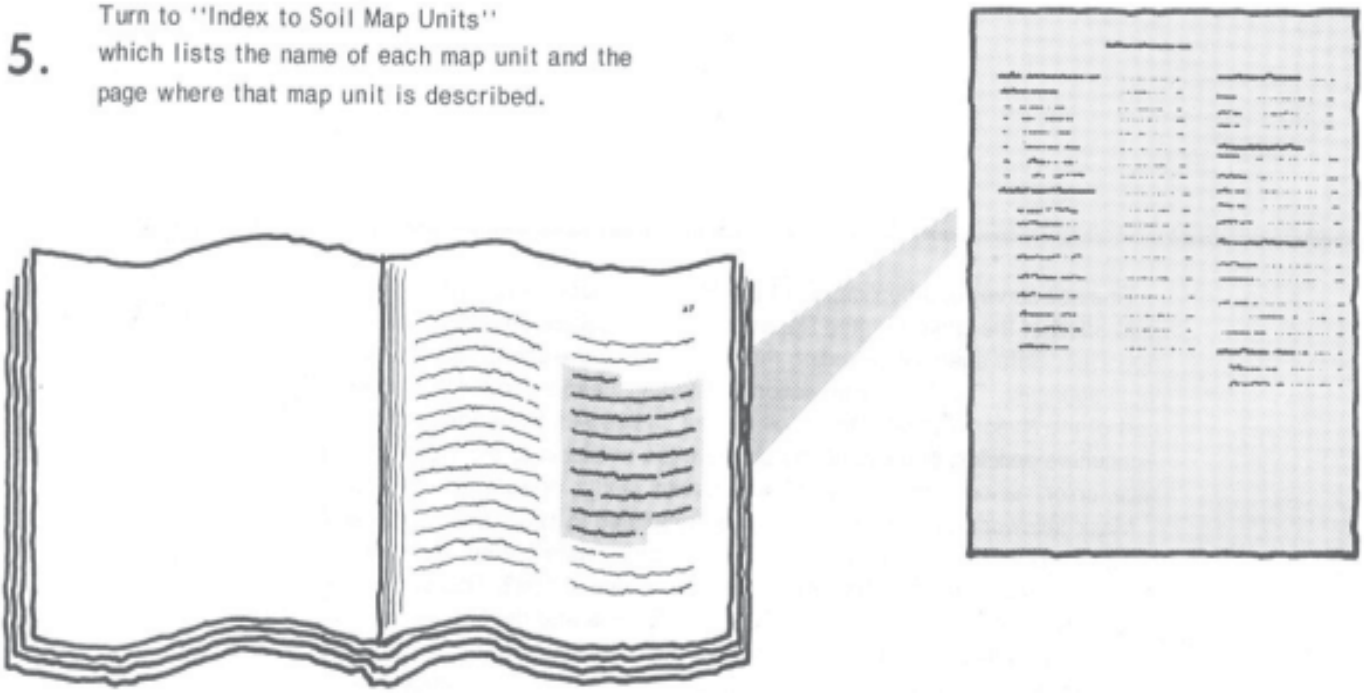


Symbols

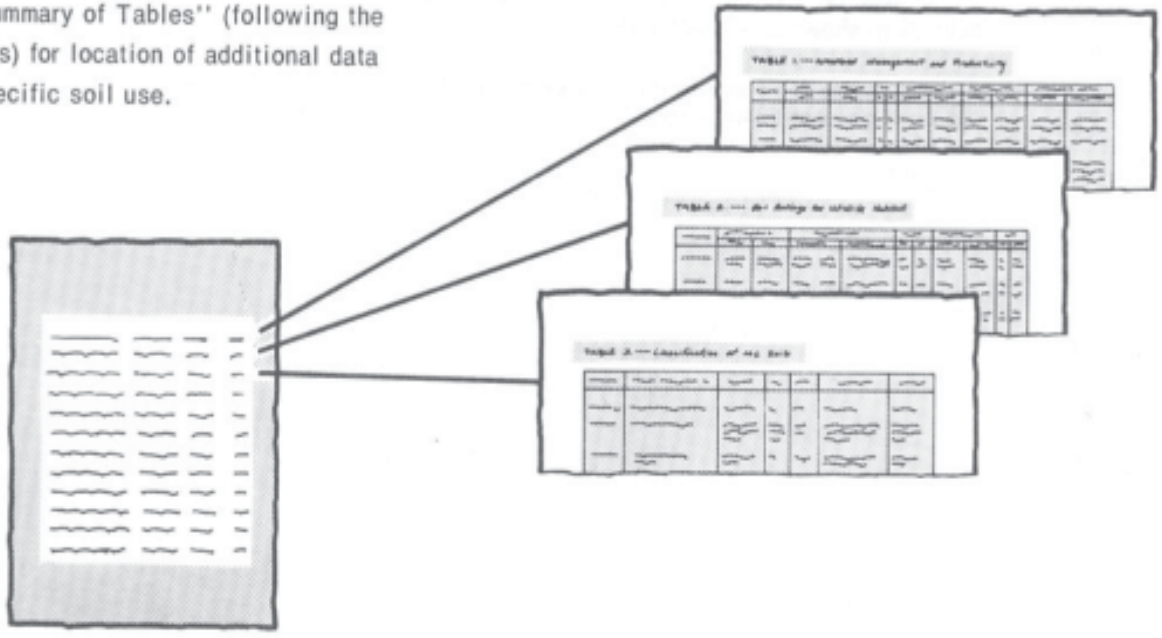
27C
56B
131B
134A
148B
151C

THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; for specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in 1983. Soil names and descriptions were approved in 1984. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1983. This survey was made cooperatively by the Soil Conservation Service and the Minnesota Agricultural Experiment Station. It is part of the technical assistance furnished to the Brown County Soil and Water Conservation District. The survey was partially funded by the Legislative Commission for Minnesota Resources and by Brown County.

Cover: An area of the Webster-Nicollet-Clarion association adjacent to Lake Hanska. The lake is in a glacial meltwater channel.

Contents

Soil Series

Issued August 1988

Index to Map Units

Summary of Tables

This page intentionally left blank

Foreword

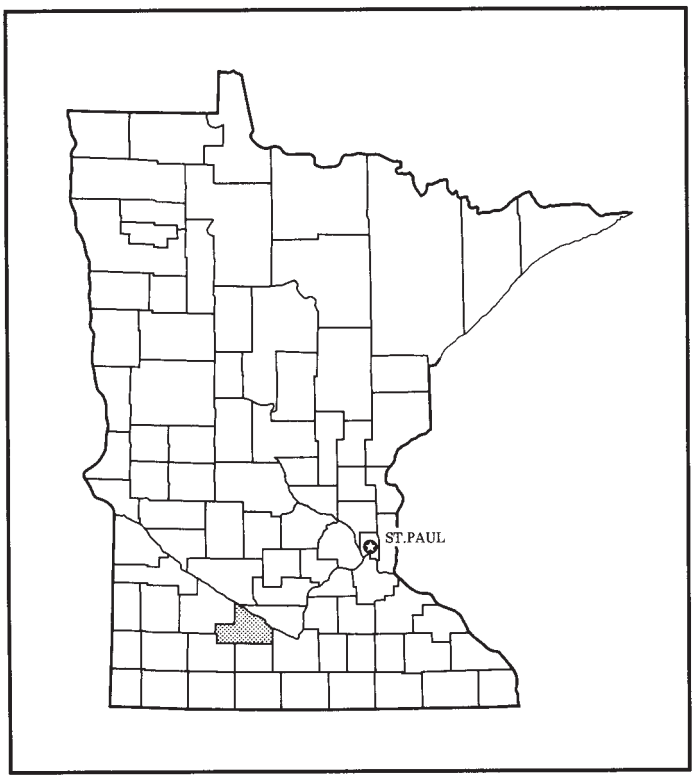
This soil survey contains information that can be used in land-planning programs in Brown County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Donald G. Ferren
State Conservationist
Soil Conservation Service



Location of Brown County in Minnesota.

Soil Survey of Brown County, Minnesota

By Keith A. Christensen, Soil Conservation Service

Fieldwork by Keith A. Christensen and Michael J. Domeier,
Soil Conservation Service, and Robert W. Anderson,
Minnesota Agricultural Experiment Station

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
the Minnesota Agricultural Experiment Station

General Nature of the County

BROWN COUNTY is in the south-central part of Minnesota. It has a total land area of 390,400 acres, or 610 square miles, and has approximately 5,500 acres of water. New Ulm, the county seat, is on the eastern edge of the county. It had a population of 13,755 in 1980. In the same year, the population of the county was 28,645.

Farming is the principal enterprise in the county. Corn, soybeans, small grain, and hay are the main crops. Beef and dairy cattle, poultry, and hogs are the main kinds of livestock.

This soil survey updates the survey of Brown County published in 1951 (*5*). It provides additional information and larger maps, which show the soils in greater detail.

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Brown County is cold in winter and quite hot in summer. Occasional cool spells occur in summer. Precipitation frequently occurs as snowstorms during the winter and as showers, which are often heavy, during the warmer months, when warm, moist air moves in from the south. The total annual rainfall is normally adequate for corn, soybeans, and small grain.

Table 1 gives data on temperature and precipitation for the survey area as recorded at New Ulm in the period 1951 to 1980. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 17 degrees F, and the average daily minimum temperature is 7 degrees. The lowest temperature on record, which occurred at New Ulm on January 9, 1977, is -37 degrees. In summer the average temperature is 71 degrees, and the average daily maximum temperature is 84 degrees. The highest recorded temperature, which occurred at New Ulm on July 9, 1976, is 104 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 28 inches. Of this, 20 inches, or more than 70 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 16 inches. The heaviest 1-day rainfall during the period of record was 5.22 inches. Thunderstorms occur on about 38 days each year. Tornadoes and severe thunderstorms strike occasionally. They are local in extent and of short duration and result in sparse damage in narrow belts. Hail falls at times during the warmer periods. It causes damage in scattered small areas.

The average seasonal snowfall is about 43 inches. The greatest snow depth at any one time during the period of record was 29 inches. On the average, 51 days of the year have at least 1 inch of snow on the ground.

The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 65 percent of the time possible in summer and 40 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 12 miles per hour, in spring.

Geology

Precambrian metamorphic and igneous rocks, mainly granite, gneiss, and Sioux quartzite, form the lowermost geologic unit in Brown County (*7*). The depth to these rocks is generally 100 to more than 200 feet. Granite and gneiss bedrock crops out only in Eden and Home Townships, in the valley of the Minnesota River. Material weathered from granite and gneiss also is evident in these townships. Sioux quartzite bedrock crops out only in Stately Township, primarily along Mound Creek and the Little Cottonwood River. Material weathered from Sioux quartzite is in Cottonwood Township, along a terrace adjacent to the Minnesota River.

Paleozoic sandstone underlies part of southeastern Brown County. Sandstone crops out in the valley of the Cottonwood River, near its junction with the Minnesota River.

Cretaceous sedimentary rocks underlie the glacial drift throughout most of the county. The rock strata are as much as 200 feet thick and occur as layers of sandstone, siltstone, and shale. In a clay pit near Springfield, these sedimentary rocks are mined for use in brick making (fig. 1). They crop out primarily in Stately and North Star Townships and in the valley of the Cottonwood River, in Sigel Township.

Glacial drift of Wisconsin age forms the uppermost geologic unit in Brown County (*6, 10*). It ranges from a few feet to more than 200 feet in thickness. Deposits of glacial till cover approximately 80 percent of the county. Glacial outwash deposits of sand and gravel cover approximately 15 percent. They were deposited by meltwater streams. The southern part of the county has a system of meltwater stream channels. Most of these channels are filled with glacial outwash, but some are filled with alluvium. Alluvium derived from the glacial drift and deposited on flood plains is the most recent geologic deposit. It covers about 5 percent of the county.

Water Supply

Water in the county is obtained from wells tapping Pleistocene glacial deposits and sedimentary and igneous rocks (*7*). The most accessible and widely used aquifers are within beds of sand and gravel buried within the glacial deposits.

In the western part of the county, the glacial deposits are shallow in some areas and some wells terminate in Cretaceous sedimentary rocks. These rocks consist mainly of shale and beds of poorly cemented sandstone and siltstone. The beds of sandstone can yield substantial supplies of water. In the southeastern part of the county, the glacial deposits are underlain by Cambrian sandstone, which also yields substantial quantities of water.

Areas of Sioux quartzite occur in the southwest corner of the county. The quartzite contains only small quantities of water. Precambrian granitic rocks underlie much of the county but are exposed only in the valley of the Minnesota River. They yield little or no water.

History

Jonathan Carver spent the winter of 1766-67 with the Sioux Indians along the Minnesota River, in the vicinity of what is now New Ulm (*4*). At that time the survey area was a prairie characterized by tall grasses and a large number of sloughs and shallow lakes. Buffalo herds moved through the region, and Indians camped near the lakes and rivers. Until the 1850's, trappers and explorers frequented the area.

The first settlers arrived in October of 1854. They located at the site of the present-day New Ulm. Early settlement was along the Minnesota and Cottonwood Rivers and the adjacent prairies. Land was steadily cleared and cultivated. Corn and potatoes were grown in some areas.

The Territorial Legislature established Brown County in February of 1855. The county was named after Joseph Renshaw Brown, who came to Minnesota in 1819 and became well known as a trader, businessman, and politician. He was a member of the Territorial Council when the county was established. In 1857, New Ulm was officially incorporated.

Brown County was originally 42,000 square miles in size. It extended west to the Missouri River and south to Iowa. After Minnesota became a state in 1858, the county was reduced in size as new counties were established.

In 1862, settlement in the county suffered a severe setback because of a Sioux uprising. As a result of treaties, the Sioux had been confined to a reservation along the Minnesota River and were dependent on annuity payments from the U.S. Government. When the payments did not arrive in 1862, the accumulated frustration of being pushed from the land poured out in the uprising, during which 153 settlers in Brown County were killed and much property was damaged. The Indians suffered unknown casualties and lost most of their reservation land as a result of the uprising.

After the Civil War and Indian uprisings and the advent of the railroads, the settlers turned their attention to the unsettled prairie. Before the railroads were built, most settlement was confined to areas close to the Minnesota River. With the exception of New Ulm, all of the towns in the county started as railroad stops. Sleepy Eye and

Figure 1.—A clay pit near Springfield.

Springfield started in the 1870's, Evan in 1887, and Comfrey and Hanskia in 1899.

Since the 1850's, Brown County has been transformed from the open prairie of the Sioux Indians to an intensively developed agricultural area. Whereas the market for the products of the early farmers was limited to areas only about 30 miles away, much of the current agricultural production is marketed overseas. Roads on virtually every section line provide transportation routes. More than 325 miles of open ditches and many tile lines help to drain the county, thus increasing agricultural production.

Physiography, Relief, and Drainage

Most of Brown County is nearly level or gently sloping. The topography is steepest along the Minnesota, Cottonwood, and Little Cottonwood Rivers and in the northern part of Stately Township. Elevation in most of the county is 1,000 to 1,100 feet above sea level. The highest elevation, in an area in the southwestern part of the county, is about 1,260 feet. The lowest, in an area in the valley of the Minnesota River along the eastern county line, is about 780 feet (*7*).

Surface water drains eastward into the Minnesota River, chiefly through the Cottonwood and Little Cottonwood Rivers. The Cottonwood River and its tributaries drain approximately 44 percent of the county. The Little Cottonwood River drains approximately 20 percent. About 18 percent of the county is drained directly by the Minnesota River, and 18 percent is drained by Morgan Creek, the Minneopa River, and the Watonwan River (*3*).

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties

may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

This page intentionally left blank.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The descriptions, names, and delineations of the soils identified on the general soil map of this county do not fully agree or join with those of the soils identified on the maps of adjacent counties. Differences are the result of a better knowledge of soils and variations in the intensity of mapping.

Soil Descriptions

Nearly Level to Very Steep, Loamy and Silty Soils on Uplands

These soils formed dominantly in loamy glacial till on uplands. They are well drained to very poorly drained. They are used mainly as cropland. Corn, soybeans, and small grain are the major crops.

1. Canisteo-Ves-Seaforth Association

Nearly level to moderately steep, poorly drained, well drained, and moderately well drained, loamy soils on ground moraines

This association is on ground moraines characterized by short, irregular slopes that rise as much as 15 feet above the low lying areas. Depressions are common. Relief is low or intermediate.

This association makes up about 21 percent of the county. It is about 35 percent Canisteo soils, 25 percent Ves soils, 15 percent Seaforth soils, and 25 percent minor soils.

Canisteo soils are poorly drained. They are nearly level and are on low lying flats or on the rims of depressions. Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer also is black clay loam. It is about 8 inches thick. The subsoil is about 24 inches thick. It is olive gray and mottled. The upper part is clay loam, and the lower part is loam. The underlying material to a depth of 60 inches is olive gray, mottled loam.

Ves soils are well drained. They are nearly level to moderately steep and are on knolls. Typically, the surface layer is black loam about 9 inches. The subsurface layer is very dark gray loam about 4 inches thick. The subsoil is dark brown and brown loam about 11 inches thick. The underlying material to a depth of 60 inches is light olive brown loam.

Seaforth soils are moderately well drained. They are nearly level and are on low knolls. Typically, the surface layer is very dark gray loam about 11 inches thick. The subsoil is loam about 15 inches thick. The upper part is brown, and the lower part is light olive brown. The underlying material to a depth of 60 inches is light olive brown, mottled loam.

Minor in this association are the poorly drained Webster soils on low flats, the moderately well drained Normania soils on low knolls, the well drained Storden soils on knolls, and the very poorly drained Glencoe and Okoboji soils in depressions.

Most of this association is used as cropland. The major crops are corn, soybeans, and small grain. These soils are well suited to crops. They have a high organic matter content and a high available water capacity. The Canisteo soils are limited by seasonal wetness and by a high lime content, which reduces crop production. Erosion is a hazard on the sloping and moderately steep Ves soils.

2. Canisteo-Glencoe-Seaforth Association

Nearly level, poorly drained, very poorly drained, and moderately well drained, loamy and silty soils on ground moraines

This association is on ground moraines characterized by short, irregular slopes that rise as much as 5 feet above the low lying areas. Depressions are common. Relief is low.

This association makes up about 1 percent of the county. It is about 40 percent Canisteo soils, 20 percent Glencoe soils, 10 percent Seaforth soils, and 30 percent minor soils.

Canisteo soils are poorly drained. They are on low flats and on the rims of depressions. Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer also is black clay loam. It is about 8 inches thick. The subsoil is about 24 inches thick. It is olive gray and mottled. The upper part is clay loam, and the lower part is loam. The underlying material to a depth of 60 inches is olive gray, mottled loam.

Glencoe soils are very poorly drained. They are in depressions. Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is about 28 inches thick. It is black. The upper part is silty clay loam, and the lower part is clay loam. The subsoil is olive gray, mottled clay loam about 13 inches thick. The underlying material to a depth of 60 inches is olive gray, mottled clay loam.

Seaforth soils are moderately well drained. They are on low knolls. Typically, the surface layer is very dark gray loam about 11 inches thick. The subsoil is loam about 15 inches thick. The upper part is brown, and the lower part is light olive brown. The underlying material to a depth of 60 inches is light olive brown, mottled loam.

Minor in this association are the poorly drained Webster soils on low flats, the moderately well drained Normania soils on low knolls, the well drained Ves soils on knolls, and the very poorly drained Okoboji soils in depressions.

Most of this association is used as cropland. The major crops are corn, soybeans, and small grain. These soils are well suited to crops. They have a high organic matter content and a high available water capacity. The Canisteo and Glencoe soils are limited by seasonal wetness. Also, a high content of lime in the Canisteo soils reduces crop production.

3. Ves-Webster-Storden Association

Nearly level to very steep, well drained and poorly drained, loamy soils on ground moraines and till plains

This association is on ground moraines and lateral moraines characterized by slopes that rise as much as 30 feet above the low lying areas. Relief is intermediate or high.

This association makes up about 1 percent of the county. It is about 30 percent Ves soils, 20 percent Webster soils, 10 percent Storden soils, and 40 percent minor soils.

Ves soils are well drained. They are nearly level to moderately steep and are on knolls. Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is very dark gray loam about 4 inches thick. The subsoil is dark brown and brown loam about 11 inches thick. The underlying material to a depth of 60 inches is light olive brown loam.

Webster soils are poorly drained. They are nearly level and are on low flats. Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer also is black clay loam about 10 inches thick. The subsoil is about 22 inches thick. It is mottled. The upper part is dark grayish brown clay loam, and the lower part is olive gray loam. The underlying material to a depth of 60 inches is light olive gray and olive gray, mottled loam.

Storden soils are well drained. They are gently sloping to very steep and are on knolls. Typically, the surface layer is dark grayish brown loam about 10 inches thick. The underlying material to a depth of 60 inches is yellowish brown and light olive brown loam.

Minor in this association are the poorly drained Canisteo and Delft soils on low flats, the moderately well drained Seaforth and Normania soils on low knolls, and the very poorly drained Glencoe and Okoboji soils in depressions.

Most of this association is used as cropland. The major crops are corn, soybeans, and small grain. These soils are well suited to crops. Erosion is a hazard on the sloping to very steep Ves and Storden soils. Seasonal wetness is a limitation in the poorly drained Webster soils.

4. Normania-Webster-Ves Association

Nearly level to moderately steep, moderately well drained, poorly drained, and well drained, loamy soils on ground moraines and till plains

This association is on ground moraines characterized by short, irregular slopes that rise as much as 15 feet above the low lying areas. Relief is low or intermediate.

This association makes up about 7 percent of the county. It is about 30 percent Normania soils, 25 percent Webster soils, 15 percent Ves soils, and 30 percent minor soils.

Normania soils are moderately well drained. They are nearly level and are on low knolls. Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is very dark gray loam about 4 inches thick. The subsoil is loam about 25 inches thick. The upper part is olive brown, and the lower part is light olive brown and mottled. The underlying material to a depth of 60 inches is light olive brown, mottled loam.

Webster soils are poorly drained. They are nearly level and are on low flats. Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer also is black clay loam about 10 inches thick. The subsoil is about 22 inches thick. It is mottled. The upper part is dark grayish brown clay loam, and the lower part is olive gray loam. The underlying material to a depth of 60 inches is light olive gray and olive gray, mottled loam.

Ves soils are well drained. They are nearly level to moderately steep and are on knolls. Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is very dark gray loam about 4 inches

thick. The subsoil is dark brown and brown loam about 11 inches thick. The underlying material to a depth of 60 inches is light olive brown loam.

Minor in this association are the well drained Storden soils on knolls, the moderately well drained Seaforth soils on low knolls, the poorly drained Canisteo soils on low flats and the rims of depressions, and the very poorly drained Glencoe and Okoboji soils in the depressions.

Most of this association is used as cropland. The major crops are corn, soybeans, and small grain. These soils are well suited to crops. They have a high organic matter content and a high available water capacity. The poorly drained Webster soils are limited by seasonal wetness. Erosion is a hazard on the sloping and moderately steep Ves soils.

5. Webster-Nicollet-Okoboji Association

Nearly level, poorly drained, moderately well drained, and very poorly drained, loamy and silty soils on till plains and ground moraines

This association is on ground moraines characterized by slopes that rise as much as 10 feet above the low lying areas. Depressions are common. Relief is low.

This association makes up about 18 percent of the county. It is about 30 percent Webster soils, 25 percent Nicollet soils, 15 percent Okoboji soils, and 30 percent minor soils.

Webster soils are poorly drained. They are on low flats. Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer also is black clay loam about 10 inches thick. The subsoil is about 22 inches thick. It is mottled. The upper part is dark grayish brown clay loam, and the lower part is olive gray loam. The underlying material to a depth of 60 inches is light olive gray and olive gray, mottled loam.

Nicollet soils are moderately well drained. They are on low knolls. Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer also is black clay loam. It is about 7 inches thick. The subsoil is clay loam about 19 inches thick. The upper part is dark grayish brown, and the lower part is olive brown and mottled. The underlying material to a depth of 60 inches is olive and light olive brown, mottled clay loam.

Okoboji soils are very poorly drained. They are in depressions. Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is black and very dark gray silty clay loam about 32 inches thick. The subsoil is olive gray, mottled silty clay loam about 8 inches thick. The underlying material to a depth of 60 inches is gray, mottled silty clay loam.

Minor in this association are the poorly drained Canisteo soils on low flats and on the rims of depressions, the well drained Clarion soils on knolls, and the very poorly drained Palms and Glencoe soils in depressions.

Most of this association is used as cropland. The major crops are corn, soybeans, and small grain. These soils are well suited to crops. They have a high organic matter content and a high available water capacity. Seasonal wetness is a limitation in the Webster and Okoboji soils.

6. Webster-Nicollet-Clarion Association

Nearly level to moderately steep, poorly drained, moderately well drained, and well drained, loamy soils on till plains and ground moraines

This association is on ground moraines characterized by short, irregular slopes that rise as much as 15 feet above the low lying areas. Depressions are common. Relief is low or intermediate.

This association makes up about 27 percent of the county. It is about 25 percent Webster soils, 20 percent Nicollet soils, 15 percent Clarion soils, and 40 percent minor soils.

Webster soils are poorly drained. They are nearly level and are on low flats. Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer also is black clay loam about 10 inches thick. The subsoil is about 22 inches thick. It is mottled. The upper part is dark grayish brown clay loam, and the lower part is olive gray loam. The underlying material to a depth of 60 inches is light olive gray and olive gray, mottled loam.

Nicollet soils are moderately well drained. They are nearly level and are on low knolls. Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer also is black clay loam. It is about 7 inches thick. The subsoil is clay loam about 19 inches thick. The upper part is dark grayish brown, and the lower part is olive brown and mottled. The underlying material to a depth of 60 inches is olive and light olive brown, mottled loam.

Clarion soils are well drained. They are nearly level to moderately steep and are on knolls. Typically, the surface layer is very dark gray loam about 10 inches thick. The subsurface layer is very dark grayish brown loam about 5 inches thick. The subsoil is dark yellowish brown and yellowish brown loam about 19 inches thick. The underlying material to a depth of 60 inches is light olive brown, mottled loam.

Minor in this association are the poorly drained Canisteo soils on low flats and on the rims of depressions, the moderately well drained Seaforth soils on low knolls, the well drained Storden soils on knolls, and the very poorly drained Glencoe and Okoboji soils in depressions.

Most of this association is used as cropland. The major crops are corn, soybeans, and small grain. These soils are well suited to crops. They have a high organic matter content and a high available water capacity. The poorly drained Webster soils are limited by seasonal

wetness. Erosion is a hazard on the sloping and moderately steep Clarion soils.

7. Clarion-Storden-Terril Association

Very steep, well drained and moderately well drained, loamy soils on till plains, ground moraines, and foot slopes

This association is on the sides of stream and river valleys. Slopes rise as much as 200 feet above the flood plains.

This association makes up about 1 percent of the county. It is about 45 percent Clarion soils, 20 percent Storden soils, 20 percent Terril soils, and 15 percent minor soils.

Clarion soils are well drained. They are on side slopes that face north or east. Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark gray loam about 7 inches thick. The subsoil is yellowish brown loam about 22 inches thick. The underlying material to a depth of 60 inches is light olive brown loam.

Storden soils are well drained. They are on side slopes that face west or south. Typically, the surface layer is dark grayish brown loam about 10 inches thick. The underlying material to a depth of 60 inches is yellowish brown and light olive brown loam.

Terril soils are moderately well drained. They are on foot slopes. Typically, the surface layer is black loam about 16 inches thick. The subsurface layer is very dark gray loam about 15 inches thick. The subsoil is dark brown loam about 15 inches thick. The underlying material to a depth of 60 inches is dark yellowish brown loam.

Minor in this association are the poorly drained Delft soils on foot slopes and in drainageways and seepy areas.

The soils in this association are generally unsuited to crops because of the slope. They are best suited to woodland. A cover of woody vegetation reduces the hazard of erosion.

Nearly Level and Gently Sloping, Loamy Soils Mainly on Valley Trains

These soils formed dominantly in loamy glacial outwash on valley trains. They are well drained to very poorly drained. They are used mainly as cropland. Corn, soybeans, and small grain are the major crops.

8. Dickman-Estherville-Lemond Association

Nearly level and gently sloping, well drained, moderately well drained, poorly drained, and very poorly drained, loamy soils on valley trains and outwash plains

This association is on valley trains and outwash plains that have low or intermediate relief. It makes up about 10 percent of the county. It is about 38 percent Dickman soils, 25 percent Estherville soils, 11 percent Lemond soils, and 26 percent minor soils.

Dickman soils are well drained and moderately well drained. They are nearly level and gently sloping and are on plane or convex slopes. Typically, the surface layer is very dark gray sandy loam about 11 inches thick. The subsoil is about 19 inches thick. The upper part is dark brown sandy loam, and the lower part is dark yellowish brown loamy sand. The underlying material to a depth of 60 inches is dark brown and yellowish brown sand.

Estherville soils are well drained. They are nearly level and gently sloping and are on plane or convex slopes. Typically, the surface layer is very dark gray sandy loam about 11 inches thick. The subsoil is about 13 inches thick. It is dark brown. The upper part is sandy loam, and the lower part is gravelly coarse sand. The underlying material to a depth of 60 inches is brown and dark yellowish brown gravelly coarse sand.

Lemond soils are poorly drained and very poorly drained. They are nearly level and are on low flats. Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is black sandy loam about 8 inches thick. The subsoil is grayish brown, mottled sandy loam about 11 inches thick. The underlying material to a depth of 60 inches is light olive gray, mottled sand.

Minor in this association are the excessively drained Sparta and Hawick soils on plane or convex slopes; the well drained Dickinson and Ridgeport soils on plane or slightly convex slopes; the moderately well drained Hoopeston and Linder soils on knolls; and the poorly drained Darfur, Fieldon, and Hanska soils on low flats and in depressions.

Most of this association is used as cropland. The major crops are corn, soybeans, and small grain. These soils are fairly well suited to crops. The Dickman and Estherville soils have a moderate or low available water capacity and thus are droughty in most years. Wind erosion is a hazard in the spring. Seasonal wetness is a limitation in the poorly drained and very poorly drained Lemond soils.

9. Lemond-Nicollet-Dickman Association

Nearly level and gently sloping, very poorly drained, poorly drained, moderately well drained, and well drained, loamy soils on valley trains, ground moraines, and outwash plains

This association is on knolls and flats on valley trains, outwash plains, and ground moraines. The moraines have low or intermediate relief.

This association makes up about 9 percent of the county. It is about 54 percent Lemond soils, 11 percent Nicollet soils, 10 percent Dickman soils, and 25 percent minor soils.

Lemond soils are poorly drained and very poorly drained. They are nearly level and are on low flats. Typically, the surface layer is black loam about 10 inches

thick. The subsurface layer is black sandy loam about 8 inches thick. The subsoil is grayish brown, mottled sandy loam about 11 inches thick. The underlying material to a depth of 60 inches is light olive gray, mottled sand.

Nicollet soils are moderately well drained. They are nearly level and are on low knolls. Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer also is black clay loam. It is about 7 inches thick. The subsoil is clay loam about 19 inches thick. The upper part is dark grayish brown, and the lower part is olive brown and mottled. The underlying material to a depth of 60 inches is olive and light olive brown, mottled loam.

Dickman soils are well drained and moderately well drained. They are nearly level and gently sloping and are on low knolls. Typically, the surface layer is very dark gray sandy loam about 11 inches thick. The subsoil is about 19 inches thick. The upper part is dark brown sandy loam, and the lower part is dark yellowish brown loamy sand. The underlying material to a depth of 60 inches is dark brown and yellowish brown sand.

Minor in this association are the well drained Clarion, Storden, and Dickinson soils on knolls; the poorly drained Webster, Canisteo, and Hanska soils on low flats; and the very poorly drained Glencoe and Hanska soils in depressions.

Most of this association is used as cropland. The major crops are corn, soybeans, and small grain. The Nicollet soils are well suited to crops because they have a high organic matter content and a high available water capacity. The Dickman soils are only fairly well suited to crops because they have a low or moderate available water capacity and thus can be droughty. Wind erosion is a hazard in the spring. Seasonal wetness is a limitation in areas of the poorly drained and very poorly drained Lemond soils.

Nearly Level, Loamy and Silty Soils on Flood Plains

These soils formed in loamy and silty alluvium on flood plains. They are poorly drained or moderately well drained. They are subject to flooding in the spring. They are used mainly as cropland. Corn, soybeans, and small grain are the dominant crops.

10. Millington-Minneiska-Calco Association

Nearly level, poorly drained and moderately well drained, loamy and silty soils on flood plains

This association is on flood plains throughout the county. It makes up about 5 percent of the county. It is about 30 percent Millington soils, 24 percent Minneiska soils, 20 percent Calco soils, and 26 percent minor soils.

Millington soils are poorly drained. They are on low flats. Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer is black and very dark gray clay loam about 28 inches thick. The underlying material to a depth of 60 inches is very dark grayish brown loam and dark grayish brown loam and sandy loam.

Minneiska soils are moderately well drained. They are on concave to slightly convex slopes. Typically, the surface layer is very dark grayish brown sandy loam about 10 inches thick. The underlying material to a depth of 60 inches is stratified grayish brown and dark grayish brown loamy sand, sandy loam, and fine sand.

Calco soils are poorly drained. They are in nearly level areas. Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is about 32 inches thick. The upper part is black silty clay loam, and the lower part is very dark gray silt loam. The underlying material to a depth of 60 inches is dark olive gray silt loam.

Minor in this association are the well drained Zumbro and moderately well drained Spillville and Hanlon soils on plane or concave slopes, the poorly drained Coland and Nishna soils on plane slopes, and the very poorly drained Oshawa and Nishna soils in oxbows and depressions.

Most of this association is used as cropland. The major crops are corn, soybeans, and small grain. These soils are well suited to crops. The main hazard is flooding following heavy rains and following snowmelt in the spring. Seasonal wetness is a limitation.

This page intentionally left blank.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series.* Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases.* Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Dickman sandy loam, 0 to 2 percent slopes, is a phase of the Dickman series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Lemond-Canisteo complex is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Okoboji and Palms soils, ponded, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Pits, gravel, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

The descriptions, names, and delineations of the soils identified on the detailed soil maps of this county do not fully agree or join with those of the soils identified on the maps of adjacent counties. Differences are the result of a better knowledge of soils and variations in the intensity of mapping.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

8B—Sparta loamy sand, 2 to 6 percent slopes. This gently sloping, excessively drained soil is on convex slopes on outwash plains and stream terraces. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface layer is very dark gray loamy sand about 10 inches thick. The subsurface layer is very dark grayish brown loamy sand about 5 inches thick. The subsoil is dark yellowish brown sand about 23 inches thick. The underlying material to a depth of about 60 inches is yellowish brown sand. In some places the subsoil and underlying material are gravelly. In other places glacial till is within 60 inches of the surface. In some areas the surface layer is sandy loam.

Included with this soil in mapping are small areas of the poorly drained Hanska and moderately well drained

Dickman soils in the lower landscape positions. These soils make up 0 to 10 percent of the mapped areas.

Permeability is rapid in the Sparta soil. Surface runoff is slow. The surface soil and subsoil are strongly acid to mildly alkaline. The available water capacity and organic matter content are low.

Most areas are used as cropland. The most common crops are small grain and soybeans. This soil is poorly suited to cultivated crops. It is poorly suited to corn because of the hazard of drought and low natural fertility. It is best suited to the crops that mature before the droughty period late in the growing season. Wind erosion is a problem, and young plants are easily damaged by windblown sand. Applying tillage methods that leave crop residue on the surface or planting field windbreaks helps to control wind erosion and conserves moisture. A fertilization program based on soil tests can help to offset the low natural fertility. The soil is well suited to irrigation if an adequate water supply is available.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. The limited available water capacity is the main management concern. Also, windblown sand can damage seedlings. The trees and shrubs that are tolerant of droughty conditions should be selected for planting. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IVs.

8C—Sparta loamy sand, 6 to 15 percent slopes. This sloping, excessively drained soil is on convex slopes on outwash plains and stream terraces. Individual areas are irregular in shape and range from 3 to 30 acres in size.

Typically, the surface layer is very dark grayish brown loamy sand about 8 inches thick. The subsurface layer is dark brown loamy sand about 4 inches thick. The subsoil is dark brown sand about 20 inches thick. The underlying material to a depth of about 60 inches is yellowish brown sand. In some places the subsoil and underlying material are gravelly. In other places glacial till is within 60 inches of the surface. In some areas the surface layer is sandy loam. In other areas the surface soil and subsoil are finer textured.

Included with this soil in mapping are small areas of the moderately well drained Terril soils on foot slopes. These soils make up 2 to 10 percent of the mapped areas.

Permeability is rapid in the Sparta soil. Surface runoff is slow. The surface soil and subsoil are strongly acid to mildly alkaline. The available water capacity and organic matter content are low.

Most areas are used as cropland. The most common crops are small grain and soybeans. Because of the low available water capacity, low natural fertility, and the hazard of wind erosion, this soil is generally unsuitable for row crops and small grain.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. The limited available water capacity and erosion by wind and water are the main management concerns. Windblown sand can damage seedlings. The trees and shrubs that are tolerant of droughty conditions should be selected for planting. Limiting site preparation to the area within 2 feet of the seedling minimizes the erosion hazard. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is VIs.

27A—Dickinson sandy loam, 0 to 2 percent slopes. This nearly level, well drained soil is on plane or slightly convex slopes on stream terraces. Individual areas are irregular in shape and range from 3 to 75 acres in size.

Typically, the surface layer is very dark gray sandy loam about 10 inches thick. The subsurface layer is very dark grayish brown sandy loam about 8 inches thick. The subsoil is about 22 inches thick. The upper part is dark brown sandy loam, and the lower part is dark yellowish brown loamy sand. The underlying material to a depth of about 60 inches is dark yellowish brown sand. In some areas it is gravelly. In other areas glacial till is within 60 inches of the surface. In some places the loamy mantle is less than 20 inches thick. In other places free carbonates are in the underlying material.

Included with this soil in mapping are small areas of the poorly drained Darfur and moderately well drained Hoopeston soils in the lower landscape positions. These soils make up 0 to 10 percent of the mapped areas.

Permeability is moderately rapid in the upper part of the Dickinson soil and rapid in the lower part. Surface runoff is medium. The surface soil and subsoil are strongly acid to neutral. The available water capacity and organic matter content are moderate.

Most areas are used as cropland. The most common crops are small grain and soybeans. This soil is fairly well suited to cultivated crops. It is best suited to the crops that mature before the droughty period late in the growing season. Droughtiness can limit production during years of low rainfall. Wind erosion is a problem, and young plants are easily damaged by windblown sand. Applying tillage methods that leave crop residue on the surface or planting field windbreaks helps to control wind erosion and conserves moisture. The soil is well suited to irrigation if an adequate supply of water is available.

This soil is suited to the trees and shrubs grown as windbreaks and environmental plantings. The limited available water capacity is the main management concern. Also, windblown sand can damage seedlings. The trees and shrubs that are tolerant of droughty conditions should be selected for planting. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIs.

27B—Dickinson sandy loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on convex slopes on stream terraces. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface soil is very dark grayish brown sandy loam about 14 inches thick. The subsoil is about 16 inches thick. The upper part is dark brown sandy loam, and the lower part is dark yellowish brown loamy sand. The underlying material to a depth of about 60 inches is yellowish brown sand. In some places it is gravelly. In other places glacial till is within 60 inches of the surface. In some areas the loamy mantle is less than 20 inches thick. In other areas free carbonates are in the underlying material.

Included with this soil in mapping are small areas of the poorly drained Darfur and moderately well drained Hoopeston soils in the lower landscape positions. These soils make up 0 to 10 percent of the mapped areas.

Permeability is moderately rapid in the upper part of the Dickinson soil and rapid in the lower part. Surface runoff is medium. The surface soil and subsoil are strongly acid to neutral. The available water capacity and organic matter content are moderate.

Most areas are used as cropland. The most common crops are small grain and soybeans. This soil is fairly well suited to cultivated crops. It is best suited to the crops that mature before the droughty period late in the growing season. Droughtiness can limit production during years of low rainfall. Because of runoff on the steeper slopes, water erosion is a hazard. Wind erosion also is a hazard, and young plants are easily damaged by windblown sand. Applying tillage methods that leave crop residue on the surface or planting field windbreaks helps to control wind erosion and conserves moisture. The soil is well suited to irrigation if an adequate water supply is available.

This soil is suited to the trees and shrubs grown as windbreaks and environmental plantings. The limited available water capacity is the main management concern. Also, windblown sand can damage seedlings. The trees and shrubs that are tolerant of droughty conditions should be selected for planting. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIe.

31E—Storden loam, 18 to 24 percent slopes. This steep, well drained soil is on ground moraines. Slopes are convex and complex and are 100 to 300 feet long. Individual areas are long and narrow and range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown loam about 10 inches thick. The underlying material to a depth of about 60 inches is loam. It is yellowish brown in the upper part and light olive brown in the lower part. In some places the soil is sandy loam throughout. In other places the surface layer is darker.

Included with this soil in mapping are small areas of Clarion, Delft, Terril, and Ves soils. The well drained Clarion and Ves soils are in the less sloping areas. The poorly drained Delft and moderately well drained Terril soils are in narrow drainageways and on foot slopes. Also included are areas where rock crops out and small pockets of sand and gravel. Inclusions make up 5 to 15 percent of the mapped areas.

Permeability is moderate in the Storden soil. Surface runoff is rapid. The soil is mildly alkaline or moderately alkaline throughout. The available water capacity is high. Organic matter content is low.

Most areas are used as woodland. Some are used as pasture. Because of the slope, this soil is unsuitable as cropland.

This soil is suited to the trees and shrubs grown as windbreaks and environmental plantings, but high growth and survival rates are unlikely. Erosion and alkalinity are management concerns. The trees that are tolerant of alkaline conditions should be selected for planting. Limiting site preparation to the area within 2 feet of the seedling minimizes the erosion hazard. Applications of herbicide help to remove competing plants.

The land capability classification is VIe.

31F—Storden loam, 24 to 60 percent slopes. This very steep, well drained soil is on south- and west-facing side slopes in stream valleys and ravines (fig. 2). Slopes are convex and complex and are 100 to 300 feet long. Individual areas are long and narrow and range from 5 to 250 acres in size.

Typically, the surface layer is dark grayish brown loam about 5 inches thick. The underlying material to a depth of about 60 inches is loam. It is light yellowish brown in the upper part and yellowish brown in the lower part. In some areas the soil is sandy loam throughout. In many places the surface layer is darker and has no free carbonates.

Included with this soil in mapping are small areas of Clarion, Delft, Hawick, Sparta, and Terril soils. The well drained Clarion soils are in landscape positions similar to those of the Storden soil. They have a dark surface layer. The poorly drained Delft and moderately well drained Terril soils are in drainageways and on foot slopes. The excessively drained Hawick and Sparta soils are on the upper part of side slopes, in areas where outwash terraces are adjacent to the stream valleys. Also included are pockets of sand and gravel and, along the Minnesota River, areas where granite bedrock and granite residuum are exposed near the base of side slopes in the river valley. Inclusions make up 5 to 15 percent of the mapped areas.

Permeability is moderate in the Storden soil. Surface runoff is rapid. The soil is mildly alkaline or moderately alkaline throughout. The available water capacity is high. Organic matter content is low.

Figure 2.—An area of Storden loam, 24 to 60 percent slopes, on an escarpment along the Cottonwood River.

Most areas are wooded. Because of the slope, this soil is unsuitable as cropland. It is fairly well suited to woodland. The most common trees are American elm, basswood, ironwood, sugar maple, bur oak, and green ash. The hazard of erosion and the slope are the main management concerns. The hazard of erosion is severe if the surface is disturbed. In most areas trees cannot be planted by machine because the soil is very steep. The side slopes that face north and east are better sites for many trees and shrubs than the south- and west-facing slopes, which are warmer and drier.

This soil is generally unsuitable for windbreaks but is suitable for environmental plantings. The slope is the

main management concern. Hand planting is generally needed. Optimum growth and survival rates are unlikely.

The land capability classification is VIIe.

35—Blue Earth mucky silt loam. This nearly level, very poorly drained soil is in depressions on ground moraines. It is subject to ponding. Individual areas are irregular in shape and range from 10 to 200 acres in size.

Typically, the surface layer is black mucky silt loam about 10 inches thick. The underlying material to a depth of about 60 inches also is black mucky silt loam. In places the soil has more clay.

Included with this soil in mapping are small areas of the poorly drained Canisteo and Essexville soils. Canisteo soils formed in glacial till in the higher landscape positions. Essexville soils are along the borders of the depressions and on sandbars that extend into the depressions on lake plains. Included soils make up 0 to 5 percent of the mapped areas.

Permeability is moderate in the Blue Earth soil. Reaction is mildly alkaline or moderately alkaline throughout the profile. The available water capacity is high or very high. Organic matter content is very high. The seasonal high water table is 2 feet above to 1 foot below the surface.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is fairly well suited to cultivated crops. The wetness and a high content of lime are the main limitations. A subsurface drainage system generally is needed before the soil can be cropped intensively. Tile drains can lower the water table and thus allow the soil to dry to a proper moisture content for tillage. The high content of lime results in a fertility imbalance. It restricts the availability of essential plant nutrients, particularly phosphorus. Crops and crop varieties that are tolerant of the high content of lime should be selected for planting.

This soil is suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of the high content of lime and the excess moisture. Untimely ponding of long duration can result in seedling mortality. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIIw.

41A—Estherville sandy loam, 0 to 2 percent slopes. This nearly level, well drained soil is on plane or slightly convex slopes on valley trains. Individual areas are irregular in shape and range from 3 to 60 acres in size.

Typically, the surface layer is very dark gray sandy loam about 11 inches thick. The subsoil is about 13 inches thick. It is dark brown. The upper part is sandy loam, and the lower part is gravelly coarse sand. The underlying material to a depth of about 60 inches is brown and dark yellowish brown gravelly coarse sand. In some places it is sand. In other places glacial till is within 60 inches of the surface. In some areas the loamy mantle is less than 10 or more than 20 inches thick.

Included with this soil in mapping are small areas of the poorly drained Hanska and Lemond and moderately well drained Linder soils in the lower landscape positions. These soils make up 2 to 10 percent of the mapped areas.

Permeability is moderately rapid in the upper part of the Estherville soil and rapid in the underlying sediments. Surface runoff is slow. The surface layer and subsoil are medium acid to neutral. The available water capacity is low. Organic matter content is moderate.

Most areas are used as cropland. The most common crops are small grain and soybeans. This soil is poorly suited to cultivated crops. Because of the hazard of drought and low natural fertility, it is poorly suited to corn. It is best suited to the crops that mature before the droughty period late in the growing season. Wind erosion is a problem, and young plants are easily damaged by windblown sand. Applying tillage methods that leave crop residue on the surface or planting field windbreaks helps to control wind erosion and conserves moisture. A fertilization program based on soil tests can help to offset the low fertility. The soil is well suited to irrigation if an adequate water supply is available.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. The droughtiness limits the number of species suitable for planting. Cultivation and applications of herbicide help to remove competing plants. Windblown sand can damage seedlings.

The land capability classification is IIIs.

41B—Estherville sandy loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on convex slopes on valley trains. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface soil is very dark gray sandy loam about 13 inches thick. The subsoil is about 14 inches thick. The upper part is dark brown sandy loam, and the lower part is dark yellowish brown gravelly coarse sand. The underlying material to a depth of about 60 inches also is dark yellowish brown gravelly coarse sand. In some places it is sand. In other places glacial till is within 60 inches of the surface. In some areas the loamy mantle is less than 10 or more than 20 inches thick.

Included with this soil in mapping are small areas of the poorly drained Hanska and Lemond and moderately well drained Linder soils in the lower landscape positions. These soils make up 0 to 10 percent of the mapped areas.

Permeability is moderately rapid in the upper part of the Estherville soil and rapid in the underlying sediments. Surface runoff is slow. The surface soil and subsoil are

medium acid to neutral. The available water capacity is low. Organic matter content is moderate.

Most areas are used as cropland. The most common crops are small grain and soybeans. This soil is poorly suited to cultivated crops. Because of the hazard of drought and low natural fertility, it is poorly suited to corn. It is best suited to the crops that mature before the droughty period late in the growing season. Water erosion is a hazard on the steeper slopes. Wind erosion also is a hazard, and young plants are easily damaged by windblown sand. Applying tillage methods that leave crop residue on the surface or planting field windbreaks helps to control wind erosion and conserves moisture. A fertilization program based on soil tests can help to offset the low natural fertility. The soil is well suited to irrigation if an adequate water supply is available.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. The droughtiness limits the number of species suitable for planting. Cultivation and applications of herbicide help to remove competing plants. Windblown sand can damage seedlings.

The land capability classification is IIIs.

85—Calco silty clay loam. This nearly level, poorly drained soil is on low flats on flood plains. It is occasionally flooded. Individual areas are generally elongated and range from 2 to 200 acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is about 32 inches thick. The upper part is black silty clay loam, and the lower part is very dark gray silt loam. The underlying material to a depth of about 60 inches is dark olive gray silt loam. In some places the surface soil is leached of lime. In other places glacial outwash is within a depth of 60 inches. In some areas the soil has more clay.

Included with this soil in mapping are small areas of the very poorly drained Oshawa and Nishna soils. These soils are in depressions below the Calco soil. They make up 0 to 5 percent of the mapped areas.

Permeability is moderate in the Calco soil. Surface runoff is slow. The soil is mildly alkaline or moderately alkaline throughout. The available water capacity and organic matter content are high. A seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. The wetness and the hazard of flooding following heavy rains and snowmelt are the main management concerns. Drainage tile generally is effective in reducing the wetness, but drainage outlets are not available in many areas. A high content of lime results in a fertility imbalance. It restricts the availability of essential plant nutrients, particularly phosphorus. Crops and crop varieties that are tolerant of the high content of lime should be selected for planting.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of the high content of lime, the excess moisture, and the flooding. Untimely flooding of long duration can result in seedling mortality. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIw.

86—Canisteo clay loam. This nearly level, poorly drained soil is on low flats and on the rims of depressions on ground moraines. Individual areas are irregular in shape and range from 3 to 600 acres in size.

Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer also is black clay loam. It is about 8 inches thick. The subsoil is about 24 inches thick. It is olive gray and mottled. The upper part is clay loam, and the lower part is loam. The underlying material to a depth of about 60 inches is olive gray, mottled loam. In some places the surface layer is leached of lime. In other places the dark surface soil is more than 24 inches thick. In some areas the soil contains gypsum crystals. In other areas the content of lime is more than 20 percent.

Included with this soil in mapping are small areas of Glencoe, Nicollet, Normania, Okoboji, and Seaforth soils. The very poorly drained Glencoe and Okoboji soils are in depressions and are subject to ponding. The moderately well drained Nicollet, Normania, and Seaforth soils are in the higher landscape positions. Also included are some areas where the surface layer and the upper part of the subsoil are silty clay, a few areas where the bulk density in the subsoil and underlying material is more than 2.0, and some areas where the slope is as much as 12 percent. Included soils make up 5 to 15 percent of the mapped areas.

Permeability is moderate in the Canisteo soil. Surface runoff is slow. The soil is mildly alkaline or moderately alkaline throughout. The available water capacity and organic matter content are high. A seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. The wetness is the main limitation. A subsurface drainage system generally is needed before the soil can be cropped intensively. Tile drains can lower the water table and thus allow the soil to dry to a proper moisture content for tillage. A high content of lime results in a fertility imbalance. It restricts the availability of essential plant nutrients, particularly phosphorus. Crops and crop varieties that are tolerant of the high content of lime should be selected for planting.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of the high content of lime and the excess

moisture. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIw.

94B—Terril loam, 2 to 6 percent slopes. This gently sloping, moderately well drained soil is on foot slopes in the uplands. Individual areas are elongated and range from 3 to 70 acres in size.

Typically, the surface layer is very dark gray loam about 10 inches thick. The subsurface layer is black and very dark gray loam about 31 inches thick. The subsoil to a depth of about 60 inches is dark yellowish brown loam. In some places the dark surface soil is more than 36 or less than 24 inches thick. In other places the soil is sandy loam throughout.

Included with this soil in mapping are small areas of Clarion, Delft, and Ves soils. The well drained Clarion and Ves soils are in landscape positions similar to those of the Terril soil. They have a dark surface soil that is less than 24 inches thick. The poorly drained Delft soils are in the lower landscape positions. Soils that have strata of sand and gravel are included areas at the mouth of ravines. Also included, on outwash plains, are soils that are underlain by sandy and gravelly material. Included soils make up 5 to 15 percent of the mapped areas.

Permeability is moderate in the Terril soil. Surface runoff is medium. The surface soil and subsoil are slightly acid or neutral. The available water capacity and organic matter content are high.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops if the runoff from the higher adjacent soils is controlled. If erosion occurs on the higher lying soils, the eroding sediment is likely to injure or smother plants growing on this soil and the runoff is likely to form gullies.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. Except for those that require an abundant supply of moisture, most climatically suited species can survive and grow well. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIe.

94C—Terril loam, 6 to 12 percent slopes. This sloping, moderately well drained soil is on foot slopes in the uplands. Individual areas are elongated and range from 3 to 50 acres in size.

Typically, the surface layer is very dark gray loam about 10 inches thick. The subsurface layer is very dark gray and very dark grayish brown loam about 25 inches thick. The subsoil is dark brown loam about 13 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown loam. In some places the dark surface soil is less than 24 or more than 36 inches thick. In other places the soil is sandy loam throughout.

Included with this soil in mapping are small areas of Clarion, Delft, and Ves soils. The well drained Clarion and Ves soils are in landscape positions similar to those of the Terril soil. They have a dark surface soil that is less than 24 inches thick. The poorly drained Delft soils are in the lower landscape positions. Soils that have strata of sand and gravel are in included areas at the mouth of ravines. Also included, on outwash plains, are soils that are underlain by sandy or gravelly material. Included soils make up 5 to 15 percent of the mapped areas.

Permeability is moderate in the Terril soil. Surface runoff is medium. The surface soil and subsoil are slightly acid or neutral. The available water capacity and organic matter content are high.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is fairly well suited to cultivated crops if the runoff from the higher adjacent soils is controlled. If erosion occurs on the higher lying soils, the eroding sediment is likely to injure or smother plants growing on this soil and the runoff is likely to form gullies.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. Except for those that require an abundant supply of moisture, most climatically suited species can survive and grow well. Erosion is a hazard. It can be controlled by limiting site preparation to the area within 2 feet of the seedling. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIIe.

102B—Clarion loam, 1 to 4 percent slopes. This gently sloping, well drained soil is on knolls on till plains. Individual areas are irregular in shape and range from 3 to 60 acres in size.

Typically, the surface layer is very dark gray loam about 10 inches thick. The subsurface layer is very dark grayish brown loam about 5 inches thick. The subsoil is dark yellowish brown and yellowish brown loam about 19 inches thick. The underlying material to a depth of about 60 inches is light olive brown loam. In some places free lime is at or near the surface. In other places accumulations of lime are in the lower part of the subsoil. In some areas the subsoil has more clay. In other areas the soil is moderately well drained.

Included with this soil in mapping are small areas of Storden and Webster soils. The well drained Storden soils are on the steeper, more convex parts of the landscape. They have a dark surface layer that is less than 7 inches thick. The poorly drained Webster soils are in the lower landscape positions. Also included are small pockets of sand and gravel and areas where the bulk density is more than 2.0. Included soils make up 5 to 15 percent of the mapped areas.

Permeability is moderate in the Clarion soil. Surface runoff is medium. The surface soil and subsoil are

medium acid to mildly alkaline. The available water capacity and organic matter content are high.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. It can be intensively cropped. Water erosion is the main hazard. Applying tillage methods that leave crop residue on the surface conserves moisture, reduces the runoff rate, and helps to control erosion. Organic matter content and tilth can be maintained by returning crop residue to the soil.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. Except for those that require an abundant moisture supply, most climatically suited species can survive and grow well. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIe.

102B2—Clarion loam, 3 to 6 percent slopes, eroded. This gently sloping, well drained soil is on knolls on till plains. Individual areas are irregular in shape and range from 3 to 25 acres in size.

Typically, the surface soil is very dark gray loam about 10 inches thick. The subsoil is dark yellowish brown loam about 17 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and light olive brown loam. In some places free lime is at or near the surface. In other places accumulations of lime are in the lower part of the subsoil. In some areas the subsoil has more clay. In other areas the soil is moderately well drained.

Included with this soil in mapping are small areas of Storden, Terril, and Webster soils. The well drained Storden soils are on the steeper, more convex parts of the landscape. They have a dark surface layer that is less than 7 inches thick. The moderately well drained Terril and poorly drained Webster soils are in the lower landscape positions. Also included are small pockets of sand and gravel. Included soils make up 5 to 15 percent of the mapped areas.

Permeability is moderate in the Clarion soil. Surface runoff is medium. The surface soil and subsoil are medium acid to mildly alkaline. The available water capacity is high. Organic matter content is medium.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. Water erosion is the main hazard. Applying tillage methods that leave crop residue on the surface, contour stripcropping, and terracing reduce the runoff rate and help to control erosion. Contour stripcropping and terraces are used where slopes are long and smooth.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. Except for those that require an abundant supply of moisture, most climatically suited species can survive and grow well. Water erosion is the main hazard. It can be controlled during site preparation by a cover of crop residue. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIe.

113—Webster clay loam. This nearly level, poorly drained soil is on low flats on till plains. Individual areas are irregular in shape and range from 3 to 1,700 acres in size.

Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer also is black clay loam about 10 inches thick. The subsoil is about 22 inches thick. The upper part is dark grayish brown, mottled clay loam, and the lower part is olive gray, mottled loam. The underlying material to a depth of about 60 inches is light olive gray and olive gray, mottled loam. In some places free lime is at or near the surface. In other places the dark surface soil is more than 24 inches thick. In some areas the subsoil has more clay.

Included with this soil in mapping are small areas of Glencoe, Nicollet, Normania, Okoboji, and Seaforth soils. The very poorly drained Glencoe and Okoboji soils are in depressions and are subject to ponding. The moderately well drained Nicollet, Normania, and Seaforth soils are in the higher landscape positions. Also included are areas where the surface layer and the upper part of the subsoil are silty clay and a few areas where the bulk density in the subsoil and underlying material is more than 2.0. Included soils make up 5 to 15 percent of the mapped areas.

Permeability is moderate in the Webster soil. Surface runoff is slow. The surface soil and subsoil are slightly acid to mildly alkaline. The available water capacity and organic matter content are high. A seasonal high water table is at a depth of 1 to 2 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. The wetness is the main limitation. It generally is reduced by drainage tile. If plowed in the fall, the soil warms up and dries out more quickly in the spring.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of excess moisture. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIw.

114—Glencoe clay loam. This nearly level, very poorly drained soil is in depressions on ground moraines. It is subject to ponding. Individual areas are irregular in shape and range from 3 to 140 acres in size.

Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer is about 28 inches thick. It is black. The upper part is silty clay loam, and the lower part is clay loam. The subsoil is olive gray,

mottled clay loam about 13 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled clay loam. In some places the dark surface soil is less than 24 inches thick. In other places a thin layer of peat is at the surface. In some areas the soil is poorly drained. In other areas the subsoil has more clay. In places the soil has less sand throughout.

Included with this soil in mapping are small areas of the very poorly drained Blue Earth and Palms soils. These soils are in landscape positions similar to those of the Glencoe soil. Blue Earth soils formed in coprogenous earth. Palms soils are muck in the upper 16 or more inches. Included soils make up 0 to 5 percent of the mapped areas.

Permeability is moderately slow in the Glencoe soil. The surface soil and subsoil are slightly acid or mildly alkaline. The available water capacity is high. Organic matter content is high or very high. A seasonal high water table is 1 foot above to 1 foot below the surface.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is fairly well suited to cultivated crops. The ponding is the main hazard. Water ponds for prolonged periods following snowmelt and heavy rains. A subsurface drainage system generally is needed before the soil can be cropped intensively. Tile drains can lower the water table and thus allow the soil to dry to a proper moisture content for tillage. A combination of drainage tile and surface inlets helps to remove surface water.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of excess surface and subsurface water. Untimely ponding of long duration can result in seedling mortality. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIIw.

128B—Grogan silt loam, 1 to 6 percent slopes. This nearly level and gently sloping, well drained soil is on terraces. Individual areas are elongated and range from 5 to 30 acres in size.

Typically, the surface layer is very dark gray silt loam about 10 inches thick. The subsurface layer is very dark grayish brown silt loam about 4 inches thick. The subsoil is dark brown silt loam about 12 inches thick. The underlying material to a depth of about 60 inches is yellowish brown, brown, and pale brown silt loam and loam. In some places glacial till is within 50 inches of the surface. In other places the dark surface soil is more than 18 inches thick.

Included with this soil in mapping are small areas of the well drained Clarion soils. These soils formed in glacial till. They are in landscape positions similar to those of the Grogan soil. They make up 0 to 5 percent of the mapped areas.

Permeability is moderately rapid in the Grogan soil. Surface runoff is slow. The surface soil and subsoil are slightly acid to mildly alkaline. The available water capacity and organic matter content are high.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is suited to cultivated crops. It can be intensively cropped. Water erosion is the main hazard. Applying tillage methods that leave crop residue on the surface conserves moisture and helps to control erosion. Returning crop residue to the soil helps to maintain the organic matter content and tilth.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. Except for those that require an abundant supply of moisture, most climatically suited species can survive and grow well. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIe.

130—Nicollet clay loam. This nearly level, moderately well drained soil is on low knolls on ground moraines. Individual areas are irregular in shape and range from 3 to 230 acres in size.

Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer also is black clay loam. It is about 7 inches thick. The subsoil is clay loam about 19 inches thick. The upper part is dark grayish brown, and the lower part is olive brown and mottled. The underlying material to a depth of about 60 inches is olive and light olive brown, mottled clay loam. In some places lime is at or near the surface. In other places accumulations of lime are in the lower part of the subsoil. In some areas the subsoil has more clay.

Included with this soil in mapping are small areas of Canisteo, Clarion, and Webster soils. The poorly drained Canisteo and Webster soils are in the lower landscape positions. The well drained Clarion soils are in the higher positions. Also included are small pockets of sand and gravel and areas of lacustrine sediments. Included soils make up 5 to 10 percent of the mapped areas.

Permeability is moderate in the Nicollet soil. Surface runoff is slow. The surface soil and subsoil are medium acid to mildly alkaline. The available water capacity and organic matter content are high. A seasonal high water table is at a depth of 2.5 to 5.0 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. It can be intensively cropped. Organic matter content and tilth can be maintained by returning crop residue to the soil. Leaving crop residue on the surface of fall-tilled fields helps to control wind erosion.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. Excess moisture in the spring may result in less than optimum growth during some years. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is I.

134—Okoboji silty clay loam. This nearly level, very poorly drained soil is in depressions on ground moraines. It is subject to ponding. Individual areas are commonly circular or oblong and range from 3 to 300 acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is black and very dark gray silty clay loam about 32 inches thick. The subsoil is olive gray, mottled silty clay loam about 8 inches thick. The underlying material to a depth of about 60 inches is gray, mottled silty clay loam. In some places the dark surface soil is less than 24 or more than 48 inches thick. In other places a thin layer of peat is at the surface.

Included with this soil in mapping are small areas of the very poorly drained Blue Earth and Palms soils. These soils are in positions on the landscape similar to those of the Okoboji soil. Blue Earth soils formed in coprogenous earth. Palms soils are organic to a depth of more than 16 inches. Included soils make up 0 to 5 percent of the mapped areas.

Permeability is moderately slow in the Okoboji soil. The surface soil and subsoil are slightly acid to moderately alkaline. The available water capacity and organic matter content are high or very high. A seasonal high water table is 1 foot above to 1 foot below the surface.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is fairly well suited to cultivated crops. The ponding is the main hazard. Water ponds for prolonged periods following snowmelt and heavy rains. A subsurface drainage system generally is needed before the soil can be cropped intensively. Tile drains can lower the water table and thus allow the soil to dry to a proper moisture content for tillage. A combination of drainage tile and surface inlets is needed to remove excess surface water.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that can withstand excess moisture. Untimely ponding of long duration can result in seedling mortality. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIIw.

136—Madelia silty clay loam. This nearly level, poorly drained soil is on low flats on glacial lake plains. Individual areas are irregular in shape and range from 3 to 20 acres in size.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is black and very dark gray silty clay loam about 10 inches thick. The subsoil is dark grayish brown, mottled silt loam about 9 inches thick. The underlying material to a depth of about 60 inches is olive gray and light olive gray, mottled silt loam. In some places free lime is at or near the surface. In other places the dark surface soil is more than 24 inches thick.

Included with this soil in mapping are small areas of the poorly drained Lemond and Tilfer Variant soils. These soils are in landscape positions similar to those of the Madelia soil. Lemond soils have sandy underlying material. Tilfer Variant soils are underlain by soft bedrock. Included soils make up 2 to 10 percent of the mapped areas.

Permeability is moderate in the Madelia soil. Surface runoff is slow. The surface soil and subsoil are slightly acid to mildly alkaline. The available water capacity is high or very high. Organic matter content is high. A seasonal high water table is at a depth of 1.0 to 2.5 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. The wetness is the main limitation. A subsurface drainage system generally is needed before the soil can be cropped intensively. Tile drains can lower the water table and thus allow the soil to dry to a proper moisture content for tillage.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of excess moisture. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIw.

140—Spicer silty clay loam. This nearly level, poorly drained soil is on low flats on glacial lake plains. Individual areas are irregular in shape and range from 3 to 200 acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is very dark gray silty clay loam about 13 inches thick. The subsoil is grayish brown, mottled silt loam about 22 inches thick. The underlying material to a depth of about 60 inches is light brownish gray, mottled silt loam. In some places the dark surface soil is more than 24 inches thick. In other places the surface layer is leached of lime.

Included with this soil in mapping are small areas of Lemond soils. These soils have sandy and gravelly underlying material. They make up 0 to 10 percent of the mapped areas.

Permeability is moderate in the Spicer soil. Surface runoff is slow. The surface soil and subsoil are mildly alkaline or moderately alkaline. The available water capacity is high or very high. Organic matter content is high. A seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. The wetness is the main limitation. A subsurface drainage system generally is needed before the soil can be cropped intensively. Tile drains can lower

the water table and thus allow the soil to dry to a proper moisture content for tillage. A high content of lime results in a fertility imbalance. It restricts the availability of essential plant nutrients, particularly phosphorus. Crops and crop varieties that are tolerant of the high content of lime should be selected for planting.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of the high content of lime and the excess moisture. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIw.

227—Lemond loam. This nearly level, poorly drained soil is on low flats on valley trains. Individual areas are irregular in shape and range from 3 to 1,000 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is black sandy loam about 8 inches thick. The subsoil is grayish brown, mottled sandy loam about 11 inches thick. The underlying material to a depth of about 60 inches is light olive gray, mottled sand. In some places glacial till is at a depth of 40 inches or more. In other places the content of coarse fragments in the underlying material is more than 5 percent. In some areas the surface layer is leached of lime. In other areas the dark surface soil is more than 24 inches thick.

Included with this soil in mapping are small areas of Dickman and Hanska soils. The moderately well drained Dickman soils are in the higher landscape positions. The poorly drained Hanska soils are in very low depressions and are subject to ponding. Included soils make up 2 to 10 percent of the mapped areas.

Permeability is moderately rapid in the upper part of the Lemond soil and rapid in the lower part. Surface runoff is slow. The surface soil and subsoil are mildly alkaline or moderately alkaline. The available water capacity is moderate. Organic matter content is high. A seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. The wetness is the main limitation. A subsurface drainage system generally is needed before the soil can be cropped intensively. Tile drains can lower the water table and thus allow the soil to dry to a proper moisture content for tillage. A high content of lime results in a fertility imbalance. It restricts the availability of essential plant nutrients, particularly phosphorus. Crops and crop varieties that are tolerant of the high content of lime should be selected for planting.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of the high content of lime and the excess moisture. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIw.

247—Linder sandy loam. This nearly level, moderately well drained soil is on plane or slightly convex slopes on valley trains and stream benches. Individual areas are irregular in shape and range from 3 to 75 acres in size.

Typically, the surface layer is black sandy loam about 9 inches thick. The subsurface layer is very dark grayish brown sandy loam about 4 inches thick. The subsoil is dark yellowish brown sandy loam about 8 inches thick. The underlying material to a depth to about 60 inches is dark grayish brown and grayish brown, mottled gravelly coarse sand. In places it is sand. In some areas glacial till is within 60 inches of the surface.

Included with this soil in mapping are small areas of Estherville, Hanska, Lemond, and Ridgeport soils. The well drained Estherville and Ridgeport soils are in the higher landscape positions. The poorly drained Hanska and Lemond soils are in the lower positions. Included soils make up 0 to 5 percent of the mapped areas.

Permeability is moderately rapid in the loamy mantle of the Linder soil and very rapid in the underlying gravelly coarse sand. Surface runoff is slow. The surface soil and subsoil are medium acid to neutral. The available water capacity is low. Organic matter content is moderate. A seasonal high water table is at a depth of 2.5 to 5.0 feet.

Most areas are used as cropland. The most common crops are small grain and soybeans. This soil is fairly well suited to cultivated crops. It is best suited to the crops that mature before the droughty period late in the growing season. Droughtiness can limit production during years of low rainfall. Wind erosion is a problem, and young plants are easily damaged by windblown sand. Applying tillage methods that leave crop residue on the surface or planting field windbreaks helps to control wind erosion and conserves moisture. The soil is well suited to irrigation if an adequate water supply is available.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. The droughtiness limits the number of species suitable for planting. Also, windblown sand can damage seedlings. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIs.

269—Millington clay loam. This nearly level, poorly drained soil is on low flats on flood plains. It is occasionally flooded. Individual areas are generally elongated and range from 3 to 200 acres in size.

Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer is black and very dark gray clay loam about 28 inches thick. The upper part of the underlying material is very dark grayish brown loam. The lower part to a depth of about 60 inches is dark

grayish brown sandy loam. In some places sand and gravel are at a depth of 40 inches or more. In other places the surface layer is leached of lime.

Included with this soil in mapping are small areas of Oshawa and Spillville soils. The very poorly drained Oshawa soils are in depressions and meander channels. The moderately well drained Spillville soils are in the higher landscape positions. Included soils make up 0 to 5 percent of the mapped areas.

Permeability is moderate in the Millington soil. Surface runoff is slow. The soil is mildly alkaline or moderately alkaline throughout. The available water capacity and organic matter content are high. A seasonal high water table is at a depth of 1 to 2 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. The wetness and the hazard of flooding following heavy rains and snowmelt are the main management concerns. Drainage tile generally is effective in reducing the wetness, but drainage outlets are not available in many areas. A high content of lime results in a fertility imbalance. It restricts the availability of essential plant nutrients, particularly phosphorus. Crops and crop varieties that are tolerant of the high content of lime should be selected for planting.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of the high content of lime, the excess moisture, and the flooding. Untimely flooding can result in seedling mortality. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIw.

281—Darfur loam. This nearly level, poorly drained soil is on low flats on outwash plains. Individual areas are irregular in shape and range from 3 to 30 acres in size.

Typically, the surface layer is very dark gray loam about 10 inches thick. The subsurface layer is very dark grayish brown loam about 9 inches thick. The subsoil is dark grayish brown, mottled fine sandy loam about 16 inches thick. The underlying material to a depth of about 60 inches is mottled loamy very fine sand. It is light olive gray in the upper part and olive gray in the lower part. In some places free lime is at or near the surface. In other places the dark surface soil is more than 24 inches thick. In some areas the soil is very poorly drained.

Included with this soil in mapping are small areas of the moderately well drained Hoopeston soils in the higher landscape positions. These soils make up 0 to 5 percent of the mapped areas.

Permeability is moderate in the upper part of the Darfur soil and moderately rapid in the lower part. Surface runoff is slow. The surface soil and subsoil are slightly acid to mildly alkaline. The available water capacity is moderate. Organic matter content is high. A seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. The wetness is the main limitation. Drainage tile generally is effective in reducing the wetness. If tilled in the fall, the soil dries out and warms up earlier in the spring.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of excess moisture. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIw.

282—Hanska sandy loam. This nearly level, poorly drained soil is on low flats on valley trains. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface layer is very dark gray sandy loam about 10 inches thick. The subsurface layer also is very dark gray sandy loam. It is about 6 inches thick. The subsoil is about 9 inches of olive gray, mottled sandy loam and coarse sandy loam. The underlying material to a depth of about 60 inches is sand. It is grayish brown in the upper part and olive gray in the lower part. In some places the dark surface soil is more than 24 inches thick. In other places the loamy mantle is less than 20 inches thick. Some areas are subject to ponding.

Included with this soil in mapping are small areas of the moderately well drained Dickman soils in the higher landscape positions. These soils make up 2 to 10 percent of the mapped areas.

Permeability is moderately rapid in the upper part of the Hanska soil and rapid in the underlying sand. Surface runoff is slow. The surface soil and subsoil are slightly acid or neutral. The available water capacity is moderate. Organic matter content is high. A seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. The wetness is the main limitation. A subsurface drainage system generally is needed before the soil can be cropped intensively. Tile drains can lower the water table and thus allow the soil to dry to a proper moisture content for tillage.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of excess moisture. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIw.

313—Spillville loam. This nearly level, moderately well drained soil is on flood plains. It is occasionally flooded. Individual areas are generally elongated and range from 3 to 200 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is black and very dark gray loam about 44 inches thick. The underlying material to a depth of about 60 inches is dark grayish brown, mottled sandy loam. In places lime is at or near the surface. In some areas the soil is stratified in the upper part. In other areas it is underlain by sand and gravel within 60 inches of the surface.

Included with this soil in mapping are small areas of the poorly drained Coland soils in the lower landscape positions. These soils make up 2 to 10 percent of the mapped areas.

Permeability is moderate in the Spillville soil. Surface runoff is slow. The surface soil and subsoil are slightly acid or neutral. The available water capacity and organic matter content are high. A seasonal high water table is at a depth of 3 to 5 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. The hazard of flooding following heavy rains and snowmelt is the main management concern.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. Untimely flooding can result in seedling mortality. The trees and shrubs selected for planting should be those that are tolerant of flooding. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIw.

317—Oshawa silty clay loam. This nearly level, very poorly drained soil is in depressions and abandoned river channels on flood plains. It is frequently flooded. Individual areas are generally elongated and range from 3 to 100 acres in size.

Typically, the surface layer is black silty clay loam about 10 inches thick. The subsurface layer is very dark gray clay loam about 25 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled loam. In some places a thin layer of muck is at the surface. In other places the surface layer and subsurface layer are leached of lime. In some areas the soil has more clay throughout.

Included with this soil in mapping are small areas of the poorly drained Calco and Millington soils in the slightly higher landscape positions. These soils make up 0 to 5 percent of the mapped areas.

Permeability is moderately slow in the Oshawa soil. Surface runoff is ponded. The soil is mildly alkaline or moderately alkaline throughout. The available water capacity is high. Organic matter content is high or very high. A seasonal high water table is 1 foot above to 1 foot below the surface.

Most areas are used as wildlife habitat. This soil is well suited to wetland wildlife habitat. It is generally unsuited to cultivated crops and to windbreaks and environmental plantings because of the flooding and the extreme wetness.

The land capability classification is VIw.

327A—Dickman sandy loam, 0 to 2 percent slopes. This nearly level, well drained soil is on plane or slightly convex valley trains and outwash plains. Individual areas are irregular in shape and range from 3 to 260 acres in size.

Typically, the surface layer is very dark gray sandy loam about 11 inches thick. The subsoil is about 19 inches thick. The upper part is dark brown sandy loam, and the lower part is dark yellowish brown loamy sand. The underlying material to a depth of about 60 inches is dark brown and yellowish brown sand. In places it is gravelly. In some areas glacial till is within 60 inches of the surface.

Included with this soil in mapping are small areas of the poorly drained Hanska and Lemond soils in the lower landscape positions. These soils make up 0 to 5 percent of the mapped areas.

Permeability is moderately rapid in the upper part of the Dickman soil and rapid in the lower part. Surface runoff is medium. The surface soil and subsoil are medium acid to neutral. The available water capacity is low. Organic matter content is moderate.

Most areas are used as cropland. The most common crops are small grain and soybeans. This soil is poorly suited to cultivated crops because of droughtiness and low natural fertility. It is best suited to the crops that mature before the droughty period late in the growing season. Wind erosion is a problem, and young plants are easily damaged by windblown sand. Applying tillage methods that leave crop residue on the surface or planting field windbreaks helps to control wind erosion and conserves moisture. A fertilization program based on soil tests can offset the low natural fertility. The soil is well suited to irrigation if an adequate water supply is available (fig. 3).

This soil is suited to the trees and shrubs grown as windbreaks and environmental plantings. The droughtiness limits the number of species suitable for planting. Also, windblown sand can damage seedlings. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIIs.

327B—Dickman sandy loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on convex slopes on valley trains and outwash plains. Individual areas are irregular in shape and range from 3 to 40 acres in size.

Typically, the surface layer is very dark gray sandy loam about 13 inches thick. The subsoil is about 31 inches thick. The upper part is dark brown sandy loam,

Figure 3.—Center-pivot irrigation in an area of Dickman sandy loam, 0 to 2 percent slopes.

and the lower part is dark yellowish brown sand. The underlying material to a depth of about 60 inches is yellowish brown sand. In places it is gravelly. In some areas glacial till is within 60 inches of the surface.

Included with this soil in mapping are small areas of the poorly drained Hanska and Lemond soils in the lower landscape positions. These soils make up 0 to 5 percent of the mapped areas.

Permeability is moderately rapid in the upper part of the Dickman soil and rapid in the lower part. Surface runoff is medium. The surface layer and subsoil are medium acid to neutral. The available water capacity is low. Organic matter content is moderate.

Most areas are used as cropland. The most common crops are small grain and soybeans. This soil is poorly suited to cultivated crops because of droughtiness and low natural fertility. It is best suited to the crops that mature before the droughty period late in the growing season. Water erosion is a hazard on the steeper slopes. Wind erosion also is a hazard, and young plants are easily damaged by windblown sand. Applying tillage methods that leave crop residue on the surface or planting field windbreaks helps to control erosion and conserves moisture. A fertilization program based on soil tests can offset the low natural fertility. The soil is well suited to irrigation if an adequate water supply is available.

This soil is suited to the trees and shrubs grown as windbreaks and environmental plantings. The droughtiness limits the number of species suitable for planting. Also, windblown land can damage seedlings. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIIe.

336—Delft clay loam. This nearly level, poorly drained soil is on ground moraines. Individual areas are elongated and range from 3 to 55 acres in size.

Typically, the surface layer is black clay loam about 18 inches thick. The subsurface layer is black and very dark gray clay loam about 30 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled clay loam. In some places glacial outwash is within 60 inches of the surface. In other places the dark surface soil is less than 24 inches thick.

Included with this soil in mapping are small areas of the moderately well drained Terril soils in the slightly higher landscape positions. These soils make up 0 to 5 percent of the mapped areas.

Permeability is moderately slow in the Delft soil. Surface runoff is slow. The surface soil is medium acid to mildly alkaline. The available water capacity and organic matter content are high. The seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. The wetness is the main limitation. A subsurface drainage system generally is needed before the soil can be cropped intensively. Tile drains can lower the water table and thus allow the soil to dry to a proper moisture content for tillage. Control of the runoff from the higher adjacent soils helps to keep eroding sediment from injuring or smothering the plants growing on this soil.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of excess moisture. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIw.

386—Okoboji muck. This nearly level, very poorly drained soil is in depressions on ground moraines. It is subject to ponding. Individual areas are commonly circular or oblong and range from 5 to 70 acres in size.

Typically, the surface layer is black muck about 10 inches thick. The subsurface layer is black silty clay loam about 28 inches thick. The subsoil is olive gray, mottled silty clay loam about 16 inches thick. The underlying material to a depth of about 60 inches also is olive gray, mottled silty clay loam. In places the muck is more than 16 inches thick. In some areas the soil is underlain by sand or loamy sand.

Included with this soil in mapping are small areas of the very poorly drained Blue Earth and Canisteo soils. Blue Earth soils formed in coprogenous earth. Canisteo soils are in the higher landscape positions. They have free lime throughout. Included soils make up 0 to 5 percent of the mapped areas.

Permeability is moderately slow in the Okoboji soil. The surface soil and subsoil are slightly acid to mildly alkaline. The available water capacity is high or very high. Organic matter content is very high. A seasonal high water table is 1 foot above to 1 foot below the surface.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is fairly well suited to cultivated crops. The wetness, wind erosion, and subsidence are the main management concerns. A subsurface drainage system generally is needed before the soil can be cropped intensively. Tile drains can lower the water table and thus allow the soil to dry to a proper moisture content for tillage. Wind erosion is a hazard because of low bulk density in the organic material. Subsidence occurs as the organic material decomposes after the soil is drained. Installing the drainage tile at a greater depth than is typical helps to overcome this limitation.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that can withstand excess moisture. Untimely ponding of long duration can result in seedling mortality. Cultivation or applications of herbicide help to remove competing plants.

The land capability classification is IIIw.

421B—Ves loam, 1 to 4 percent slopes. This nearly level and gently sloping, well drained soil is on knolls on ground moraines. Individual areas are irregular in shape and range from 3 to 20 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is very dark gray loam about 4 inches thick. The subsoil is dark brown and brown loam about 11 inches thick. The underlying material to a depth of about 60 inches is light olive brown loam. In some places free lime is at or near the surface. In other places the lower part of the subsoil has no accumulations of lime. In some areas the dark surface layer is less than 7 inches thick.

Included with this soil in mapping are small areas of the poorly drained Webster soils in the lower landscape positions. Also included are small pockets of sand and gravel. Included soils make up 5 to 15 percent of the mapped areas.

Permeability is moderate in the Ves soil. Surface runoff is medium. The surface soil and subsoil are slightly acid to moderately alkaline. Available water capacity and organic matter content are high.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. It can be intensively cropped. Water erosion is the main hazard. Applying tillage methods that leave crop residue on the surface conserves moisture and helps to control erosion. Returning crop residue to the soil helps to maintain the organic matter content and tilth.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. Except for those that require an abundant supply of moisture, most

climatically suited species can survive and grow well. Cultivation or applications of herbicide help to remove competing plants.

The land capability classification is IIe.

421B2—Ves loam, 3 to 6 percent slopes, eroded. This gently sloping, well drained soil is on knolls on ground moraines. Individual areas are irregular in shape and range from 3 to 20 acres in size.

Typically, the surface layer is very dark gray loam 10 inches thick. The subsoil is dark yellowish brown loam about 15 inches thick. The underlying material to a depth of about 60 inches is light olive brown loam. In some places free lime is at or near the surface. In other places the lower part of the subsoil has no accumulations of lime. In a few areas the dark surface layer is less than 7 inches thick.

Included with this soil in mapping are small areas of Terril and Webster soils. The moderately well drained Terril soils are on foot slopes. The poorly drained Webster soils are in the lower landscape positions. Also included are small pockets of sand and gravel. Included soils make up 5 to 15 percent of the mapped areas.

Permeability is moderate in the Ves soil. Surface runoff is medium. The surface layer and subsoil are slightly acid to moderately alkaline. The available water capacity is high. Organic matter content is moderate.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. Water erosion is the main hazard. Applying tillage methods that leave crop residue on the surface, contour stripcropping, and terracing help to control runoff and erosion. Contour stripcropping and terraces are used where slopes are long and smooth.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. Except for those that require an abundant supply of moisture, most climatically suited species can survive and grow well. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIe.

423—Seaforth loam. This nearly level, moderately well drained soil is on low knolls on ground moraines. Individual areas are irregular in shape and range from 3 to 15 acres in size.

Typically, the surface layer is very dark gray loam about 11 inches thick. The subsoil is loam about 15 inches thick. The upper part is brown, and the lower part is light olive brown. The underlying material to a depth of about 60 inches is light olive brown, mottled loam. In places the surface layer is leached of lime. In some areas the underlying material is fine sandy loam or sandy loam.

Included with this soil in mapping are small areas of the poorly drained Canisteo and Webster soils in the lower landscape positions. Also included are small pockets of sand and gravel. Included soils make up 5 to 15 percent of the mapped areas.

Permeability is moderate in the Seaforth soil. Surface runoff is medium or slow. The soil is mildly alkaline or moderately alkaline throughout. The available water capacity and organic matter content are high. A seasonal high water table is at a depth of 3 to 6 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. It can be intensively cropped. A high content of lime results in a fertility imbalance. It restricts the availability of essential plant nutrients, particularly phosphorus. Crops and crop varieties that are tolerant of the high content of lime should be selected for planting. Returning crop residue to the soil helps to maintain the organic matter content and tilth. Leaving crop residue on the surface of fall-plowed fields helps to control wind erosion.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of the high content of lime. Excess moisture in the spring can result in less than optimum growth during some years. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIs.

446—Normania loam. This nearly level, moderately well drained soil is on low knolls on ground moraines. Individual areas are irregular in shape and range from 3 to 100 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is very dark gray loam about 4 inches thick. The subsoil is loam about 25 inches thick. The upper part is olive brown, and the lower part is light olive brown and mottled. The underlying material to a depth of about 60 inches is light olive brown, mottled loam. In places free lime is at or near the surface. In some areas the underlying material is sandy loam.

Included with this soil in mapping are small areas of the poorly drained Canisteo and Webster soils in the lower landscape positions. Also included are small pockets of sand and gravel and areas where the subsoil and underlying material are very dense. Included soils make up 5 to 15 percent of the mapped areas.

Permeability is moderate in the Normania soil. Surface runoff is medium or slow. The surface soil and subsoil are slightly acid to moderately alkaline. The available water capacity and organic matter content are high. A seasonal high water table is at a depth of 2.5 to 6.0 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. It can be intensively cropped. Returning crop residue to the soil helps to maintain the organic matter content and tilth. Leaving crop residue on the surface of fall-tilled fields helps to control wind erosion.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. Excess moisture in the spring can result in less than optimum growth during some years. Cultivation or applications of herbicide help to remove competing plants.

The land capability classification is I.

463—Minneiska sandy loam. This nearly level, moderately well drained soil is on flood plains. It is occasionally flooded. Individual areas are elongated and range from 3 to 180 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 10 inches thick. The underlying material to a depth of about 60 inches is dark grayish brown and grayish brown, stratified loamy sand, sandy loam, and fine sand. In places the surface layer is leached of lime. In some areas the soil has more sand throughout. In other areas it is not stratified.

Included with this soil in mapping are small areas of the very poorly drained Oshawa soils in depressions and meander channels. These soils make up 0 to 10 percent of the mapped areas.

Permeability is moderately rapid in the Minneiska soil. Surface runoff is slow. The soil is mildly alkaline or moderately alkaline throughout. The available water capacity and organic matter content are moderate. A seasonal high water table is at a depth of 3 to 6 feet.

Most areas are used as cropland. Some are used as woodland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. The hazard of flooding following heavy rains and snowmelt is the main management concern.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. Untimely flooding can result in seedling mortality. The trees and shrubs selected for planting should be those that are tolerant of flooding. Cultivation or applications of herbicide help to remove competing plants.

The land capability classification is IIw.

487—Hoopeston sandy loam. This nearly level, moderately well drained soil is on low knolls on outwash plains. Individual areas are irregular in shape and range from 3 to 30 acres in size.

Typically, the surface layer is black sandy loam about 15 inches thick. The subsoil is about 24 inches thick. The upper part is olive brown fine sandy loam, and the lower part is light olive brown, mottled loamy fine sand. The underlying material to a depth of about 60 inches is light yellowish brown loamy fine sand. In places glacial till is within 60 inches of the surface.

Included with this soil in mapping are small areas of Darfur and Dickinson soils. The poorly drained Darfur soils are in the lower landscape positions. The well drained Dickinson soils are in the higher positions. Included soils make up 5 to 10 percent of the mapped areas.

Permeability is moderately rapid in the upper part of the Hoopeston soil and rapid in lower part. Surface runoff is slow. The surface layer and subsoil are medium acid to neutral. The available water capacity is moderate. Organic matter content is high. A seasonal high water table is at a depth of 2.5 to 5.0 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. It is best suited to the crops that mature before the droughty period late in the growing season. Drought and wind erosion are the main hazards. Droughtiness can limit production during years of low rainfall. Windblown sand can easily damage young plants. Applying tillage methods that leave crop residue on the surface or planting field windbreaks helps to control wind erosion and conserves moisture.

This soil is suited to the trees and shrubs grown as windbreaks and environmental plantings. The droughtiness is the main management concern. Also, windblown sand can damage seedlings. The trees and shrubs selected for planting should be those that are tolerant of droughty conditions. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIs.

495—Zumbro loamy sand. This nearly level, well drained soil is in relatively high positions on flood plains. It is subject to rare flooding. Individual areas are irregular in shape and range from 5 to 60 acres in size.

Typically, the surface layer is black loamy sand about 10 inches thick. The subsurface layer is loamy sand about 27 inches thick. The upper part is black, and the lower part is very dark grayish brown. The subsoil is dark brown loamy sand about 16 inches thick. The underlying material to a depth of about 60 inches is grayish brown coarse sand. Some areas are not subject to flooding. In places the dark surface soil is less than 24 inches thick.

Included with this soil in mapping are small areas of the moderately well drained Minneiska soils. These soils are in landscape positions similar to those of the Zumbro soil. They are stratified. They make up 0 to 10 percent of the mapped areas.

Permeability is rapid in the Zumbro soil. Surface runoff is slow. The surface soil and subsoil are medium acid to mildly alkaline. The available water capacity is low or moderate. Organic matter content is moderate.

Most areas are used as cropland. The most common crops are small grain and soybeans. This soil is fairly well suited to cultivated crops. Drought and flooding are the main hazards. Crops that have low moisture requirements should be selected for planting.

This soil is suited to the trees and shrubs grown as windbreaks and environmental plantings. The droughtiness and the hazard of flooding are the main management concerns. Also, windblown sand can damage seedlings. The trees and shrubs that are

tolerant of flooding and of droughty conditions should be selected for planting. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIIs.

499—Hanska loam, depressional. This nearly level, very poorly drained soil is in depressions on valley trains. It is subject to ponding. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is loam about 20 inches thick. The upper part is black, and the lower part is very dark gray. The subsoil is dark grayish brown, mottled sandy loam about 7 inches thick. The underlying material to a depth of about 60 inches is gray, mottled sand. In some places glacial till is within 60 inches of the surface. In other places a thin layer of muck is at the surface. In some areas the underlying material is loamy sand or loamy fine sand. In other areas the depth to free lime is more than 60 inches.

Included with this soil in mapping are small areas of the very poorly drained Blue Earth soils. These soils are in landscape positions similar to those of the Hanska soil. They formed in coprogenous earth. They make up 0 to 5 percent of the mapped areas.

Permeability is moderately rapid in the upper part of the Hanska soil and rapid in the underlying material. Surface runoff is slow to ponded. The surface soil and subsoil are slightly acid or neutral. The available water capacity is moderate. Organic matter content is high. A seasonal high water table is 1.0 foot above to 2.5 feet below the surface.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is fairly well suited to cultivated crops. The wetness is the main limitation. A subsurface drainage system generally is needed before the soil can be cropped intensively. Tile drains can lower the water table and thus allow the soil to dry to a proper moisture content for tillage.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of excess moisture. Untimely ponding of long duration can result in seedling mortality. Cultivation or applications of herbicide help to remove competing plants.

The land capability classification is IIIw.

518—Kalmarville sandy loam. This nearly level, poorly drained soil is on flood plains. It is occasionally flooded. Individual areas are elongated and range from 3 to 175 acres in size.

Typically, the surface layer is very dark grayish brown sandy loam about 15 inches thick. The underlying material to a depth of about 60 inches is dark grayish brown, mottled, stratified sandy loam, loamy sand, sand, and coarse sand. In places the surface layer is leached of lime. In some areas the underlying material is gravelly.

Included with this soil in mapping are small areas of the poorly drained Coland and Millington soils. These soils are finer textured than the Kalmarville soil and have a thick, dark surface layer. They make up 5 to 10 percent of the mapped areas.

Permeability is moderately rapid in the Kalmarville soil. Surface runoff is slow. The soil is neutral or mildly alkaline throughout. The available water capacity and organic matter content are moderate. A seasonal high water table is within a depth of 1 foot.

Most areas are used as woodland or pasture. Some are used as cropland. The most common crops are corn and soybeans. This soil is fairly well suited to cultivated crops. The hazard of flooding following heavy rains and snowmelt is the main management concern. Also, access to some areas is limited because of steep adjacent slopes and because of small streams that meander across the landscape.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. Untimely flooding can result in seedling mortality. The trees and shrubs selected for planting should be those that are tolerant of flooding. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIw.

539—Palms muck. This nearly level, very poorly drained soil is in depressions on ground moraines. It is subject to ponding. Individual areas are irregular in shape and range from 5 to 125 acres in size.

Typically, the surface layer is black muck about 10 inches thick. The subsurface layer also is black muck. It is about 12 inches thick. The underlying material to a depth of about 60 inches is black silty clay loam. In some areas, generally near the perimeter of the depressions, the muck is less than 16 inches thick.

Included with this soil in mapping are small areas of Blue Earth, Canisteo, and Essexville soils. The very poorly drained Blue Earth soils formed in coprogenous earth. Their positions on the landscape are similar to those of the Palms soil. The poorly drained Canisteo soils and the Essexville soils are on the rims of the depressions. Included soils make up 0 to 5 percent of the mapped areas.

Permeability is moderate in the organic part of the Palms soil and moderately slow in the loamy material. The organic material is slightly acid to mildly alkaline. The available water capacity and organic matter content are very high. A seasonal high water table is 1 foot above to 1 foot below the surface.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is fairly well suited to cultivated crops. Wetness, wind erosion, and subsidence are the main problems. A subsurface drainage system generally is needed before the soil can

be cropped intensively. Tile drains can lower the water table and thus allow the soil to dry to a proper moisture content for tillage. Wind erosion is a hazard because of low bulk density in the organic material. Subsidence occurs as the organic material decomposes after the soil is drained. Installing the drainage tile at a greater depth than is typical helps to overcome this limitation.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of excess moisture. Untimely ponding of long duration can result in seedling mortality. Cultivation or applications of herbicide help to remove competing plants.

The land capability classification is IIIw.

574—Du Page loam. This nearly level, moderately well drained soil is on flood plains. It is occasionally flooded. Individual areas are irregular in shape and range from 3 to 130 acres in size.

Typically, the surface layer is very dark gray loam about 10 inches thick. The subsurface layer is loam about 36 inches thick. The upper part is very dark gray, and the lower part is very dark grayish brown. The underlying material to a depth of about 60 inches is very dark gray loam. In some places the soil has less sand and more clay. In other places it is more stratified.

Included with this soil in mapping are small areas of Minneiska and Nishna soils. Minneiska soils are in landscape positions similar to those of the Du Page soil. They are coarser textured than the Du Page soil. The poorly drained Nishna soils in the lower landscape positions. Also included are areas where granite bedrock or granite residuum is within 60 inches of the surface. Included soils make up 5 to 15 percent of the mapped areas.

Permeability is moderate in the Du Page soil. Surface runoff is slow. The soil is mildly alkaline or moderately alkaline throughout. The available water capacity and organic matter content are high. A seasonal high water table is at a depth of 4 to 6 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops if it is protected against flooding. Flooding is a hazard following heavy rains and snowmelt. It can be controlled by dikes along the streams or rivers.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. Untimely flooding can result in seedling mortality. The trees and shrubs selected for planting should be those that are tolerant of flooding. Cultivation or applications of herbicide help to remove competing plants.

The land capability classification is IIw.

575—Nishna silty clay. This nearly level, poorly drained soil is on low flats on flood plains. It is occasionally flooded. Individual areas are irregular in shape and range from 3 to 200 acres in size.

Typically, the surface layer is black silty clay about 10 inches thick. The subsurface layer is silty clay about 29 inches thick. The upper part is very dark gray, and the lower part is black. The underlying material to a depth of about 60 inches is very dark gray silty clay. In some places the soil has more sand and less clay. In other places the surface layer has no free carbonates. In some areas the soil is wetter.

Included with this soil in mapping are small areas of the moderately well drained Du Page soils in the higher landscape positions. Also included are areas where granite bedrock or granite residuum is within 60 inches of the surface. Included soils make up 0 to 10 percent of the mapped areas.

Permeability is slow in the Nishna soil. Surface runoff also is slow. The soil is mildly alkaline or moderately alkaline throughout. The available water capacity is moderate. Organic matter content is high. A seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is fairly well suited to cultivated crops. The wetness and the hazard of flooding following heavy rains and snowmelt are the main problems. Drainage tile generally is effective in reducing the wetness, but drainage outlets are not available in many areas. A high content of lime results in a fertility imbalance. It restricts the availability of essential plant nutrients, particularly phosphorus. Crops and crop varieties that are tolerant of the high content of lime should be selected for planting.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of the high content of lime, the excess moisture, and the flooding. Untimely flooding of long duration can result in seedling mortality. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIIw.

603—Hanlon sandy loam. This nearly level, moderately well drained soil is on flood plains. It is occasionally flooded. Individual areas are elongated and range from 3 to 200 acres in size.

Typically, the surface layer is black sandy loam about 10 inches thick. The subsurface layer is very dark gray sandy loam about 34 inches thick. The subsoil is very dark gray sandy loam about 13 inches thick. The underlying material to a depth of about 60 inches is very dark grayish brown sandy loam. In places sand and gravel are within 60 inches of the surface. In some areas the soil has more clay. In other areas it is more stratified.

Included with this soil in mapping are small areas of the poorly drained Coland soils in the lower positions on

the landscape. These soils make up 2 to 10 percent of the mapped areas.

Permeability is moderately rapid in the Hanlon soil. Surface runoff is slow. The surface soil and subsoil are medium acid to neutral. The available water capacity is moderate. Organic matter content is high. A seasonal high water table is at a depth of 3 to 5 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. The moderate available water capacity and the hazard of flooding following heavy rains and snowmelt are the main problems.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. Untimely flooding can result in seedling mortality. The trees and shrubs selected for planting should be those that are tolerant of flooding. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIs.

611B—Hawick coarse sandy loam, 2 to 6 percent slopes. This gently sloping, excessively drained soil is on convex slopes on valley trains. Individual areas are irregular in shape and range from 5 to 25 acres in size.

Typically, the surface layer is very dark gray coarse sandy loam about 9 inches thick. The subsurface layer is very dark grayish brown loamy coarse sand about 3 inches thick. The subsoil is dark yellowish brown gravelly coarse sand about 6 inches thick. The underlying material to a depth of about 60 inches is yellowish brown gravelly coarse sand. In places glacial till is within 60 inches of the surface. In some areas the subsoil and underlying material are sand.

Included with this soil in mapping are small areas of the moderately well drained Linder soils in the lower landscape positions. These soils make up 0 to 5 percent of the mapped areas.

Permeability is very rapid in the Hawick soil. Surface runoff is slow. The surface soil and subsoil are slightly acid to mildly alkaline. The available water capacity is low. Organic matter content is low or moderate.

Most areas are used as cropland. The most common crops are small grain and soybeans. This soil is poorly suited to cultivated crops because of droughtiness and low natural fertility. It is best suited to the crops that mature before the droughty period late in the growing season. Water erosion is a hazard on the steeper slopes. Wind erosion also is a hazard, and young plants are easily damaged by windblown sand. Applying tillage methods that leave crop residue on the surface or planting field windbreaks helps to control wind erosion and conserves moisture. A fertilization program based on soil tests helps to offset the low natural fertility. The soil is well suited to irrigation if an adequate water supply is available.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. The low available water capacity is the main management concern. Also, windblown sand can damage seedlings. The trees and shrubs that are tolerant of droughty conditions should be selected for planting. Cultivation or applications of herbicide help to remove competing plants.

The land capability classification is IVs.

611C—Hawick coarse sandy loam, 6 to 15 percent slopes. This sloping, excessively drained soil is on convex slopes on valley trains. Individual areas are irregular in shape and range from 5 to 20 acres in size.

Typically, the surface layer is very dark grayish brown coarse sandy loam about 9 inches thick. The subsoil is dark brown gravelly coarse sand about 7 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown and yellowish brown gravelly coarse sand. In places glacial till is within 60 inches of the surface. In some areas the subsoil and underlying material are sand.

Included with this soil in mapping are small areas of the moderately well drained Linder and Terril soils. Linder soils are in the lower landscape positions. Terril soils are on foot slopes. Included soils make up 0 to 10 percent of the mapped areas.

Permeability is very rapid in the Hawick soil. Surface runoff is medium. The surface layer and subsoil are slightly acid to mildly alkaline. The available water capacity is low. Organic matter content is low or moderate.

Most areas are used as cropland. The most common crops are small grain and soybeans. Because of the low available water capacity, low natural fertility, and a severe hazard of water erosion, this soil is poorly suited to row crops and small grain. Wind erosion is a hazard, and young plants are easily damaged by windblown sand. Applying tillage methods that leave crop residue on the surface helps to control erosion and conserves moisture. A fertilization program based on soil tests helps to offset the low natural fertility.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. The low available water capacity and erosion by wind and water are the main management concerns. Windblown sand can damage seedlings. The trees and shrubs that are tolerant of droughty conditions should be selected for planting. Limiting site preparation to the area within 2 feet of the seedling minimizes the erosion hazard. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IVs.

639—Ridgeport sandy loam. This nearly level, somewhat excessively drained soil is on plane or slightly convex slopes on alluvial stream benches. Individual areas are irregular in shape and range from 3 to 35 acres in size.

Typically, the surface soil is black sandy loam about 12 inches thick. The subsoil is about 15 inches thick. It is dark yellowish brown. The upper part is sandy loam, and the lower part is coarse sandy loam. The underlying material to a depth of about 60 inches is yellowish brown gravelly coarse sand. In places it is sand. In some areas glacial till is within 60 inches of the surface.

Included with this soil in mapping are small areas of the poorly drained Hanska and moderately well drained Linder soils in the lower landscape positions. These soils make up 0 to 10 percent of the mapped areas.

Permeability is moderately rapid in the loamy mantle of the Ridgeport soil and very rapid in the underlying sand and gravel. Surface runoff is medium. The surface soil and subsoil are medium acid to neutral. The available water capacity and organic matter content are moderate.

Most areas are used as cropland. The most common crops are small grain and soybeans. This soil is fairly well suited to cultivated crops. It is best suited to the crops that mature before the droughty period late in the growing season. Droughtiness can limit production during years of low rainfall. Wind erosion is a problem, and young plants are easily damaged by windblown sand. Applying tillage methods that leave crop residue on the surface or planting field windbreaks helps to control wind erosion and conserves moisture. The soil is well suited to irrigation if an adequate water supply is available.

This soil is suited to the trees and shrubs grown as windbreaks and environmental plantings. The droughtiness limits the number of species suitable for planting. Also, windblown sand can damage seedlings. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIIs.

820B—Dickman-Clarion complex, 2 to 6 percent slopes. These gently sloping, well drained soils are on knolls on valley trains and till plains. Individual areas are irregular in shape and range from 5 to 30 acres in size. They are about 50 percent Dickman soil and 40 percent Clarion soil. The two soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Dickman soil has a surface layer of black sandy loam about 10 inches thick. The subsurface layer is very dark gray sandy loam about 7 inches thick. The subsoil is brown and dark yellowish brown loamy sand about 18 inches thick. The underlying material to a depth of about 60 inches is dark brown sand. In places the surface layer is loamy sand. In some areas the soil is moderately well drained.

Typically, the Clarion soil has a surface layer of black loam about 13 inches thick. The subsoil is dark yellowish brown loam about 15 inches thick. The underlying material to a depth of about 60 inches is light olive brown loam. In places the surface layer is sandy loam or loamy sand.

Included with these soils in mapping are small areas of Nicollet and Terril soils in the lower landscape positions. These included soils make up about 10 percent of the mapped areas.

Permeability is moderate in the Clarion soil. It is moderately rapid in the upper part of the Dickman soil and rapid in the lower part. Surface runoff is medium on both soils. Reaction is medium acid to mildly alkaline in the surface layer and subsoil of the Clarion soil and medium acid to neutral in the surface soil and subsoil of the Dickman soil. The available water capacity is high in the Clarion soil and low in the Dickman soil. Organic matter content is high in Clarion soil and moderate in Dickman soil.

Most areas are used as cropland. The most common crops are small grain and soybeans. These soils are fairly well suited to cultivated crops. The Dickman soil is subject to wind erosion and is droughty in most years. It is best suited to the crops that have low moisture requirements. Windblown sand can damage young plants. Applying tillage methods that leave crop residue on the surface helps to control wind erosion and conserves moisture.

These soils are suitable for the trees and shrubs grown as windbreaks and environmental plantings. The main management concerns are droughtiness and wind erosion in areas of the Dickman soil. Windblown sand can damage seedlings. The trees and shrubs that are tolerant of droughty conditions should be selected for planting. Cultivation and applications of herbicides help to remove competing plants.

The land capability classification is IIIe.

919—Lemond-Canisteo complex. These nearly level, poorly drained soils are on low flats on valley trains and ground moraines. Individual areas are irregular in shape and range from 5 to 440 acres in size. They are about 50 percent Lemond soil and 40 percent Canisteo soil. The two soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Lemond soil has a surface soil of black loam about 15 inches thick. The subsoil is about 12 inches thick. The upper part is grayish brown, mottled sandy loam, and the lower part is olive gray, mottled loamy sand. The underlying material to a depth of about 60 inches is light olive gray, mottled sand. In some places it is gravelly. In other places the dark surface soil is more than 24 inches thick.

Typically, the Canisteo soil has a surface soil of black clay loam about 16 inches thick. The subsoil is olive gray, mottled clay loam about 19 inches thick. The underlying material to a depth of about 60 inches is light olive gray, mottled loam. In some places the surface layer is leached of lime. In other places the dark surface soil is more than 24 inches thick. In some areas the surface layer is sandy loam.

Included with these soils in mapping are small areas of the moderately well drained Dickman soils and the very poorly drained Glencoe and Hanska soils. Dickman soils are in the higher landscape positions. Glencoe and Hanska soils are in depressions and are subject to ponding. Also included are a few areas where the Canisteo soil has a bulk density of more than 1.8 in the subsoil and underlying material. Included soils make up about 10 percent of the mapped areas.

Permeability is moderately rapid in the upper part of the Lemond soil and rapid in the lower part. It is moderate in the Canisteo soil. Surface runoff is slow on both soils. Reaction is mildly alkaline or moderately alkaline throughout the profile. The available water capacity is moderate in the Lemond soil and high in the Canisteo soil. Organic matter content is high in both soils. A seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. These soils are well suited to cultivated crops. The wetness is the main limitation. A subsurface drainage system is generally needed before the soils can be cropped intensively. Tile drains can lower the water table and thus allow the soils to dry to a proper moisture content for tillage. A high content of lime results in a fertility imbalance. It restricts the availability of essential plant nutrients, particularly phosphorus. Crops and crop varieties that are tolerant of the high content of lime should be selected for planting.

These soils are well suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of the high content of lime and the excess moisture. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIw.

920B—Clarion-Estherville-Storden complex, 2 to 6 percent slopes. These gently sloping, well drained soils are on knolls on till plains. Individual areas are irregular in shape and range from 5 to 30 acres in size. They are about 50 percent Clarion soil, 25 percent Estherville soil, and 15 percent Storden soil. The three soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Clarion soil has a surface layer of very dark brown loam about 10 inches thick. The subsoil is dark yellowish brown loam about 13 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loam. In places free lime is at or near the surface.

Typically, the Estherville soil has a surface layer of very dark grayish brown sandy loam about 10 inches thick. The subsoil is about 12 inches thick. The upper part is dark brown sandy loam, and the lower part is yellowish brown loamy coarse sand. The underlying material to a depth of about 60 inches is yellowish brown gravelly coarse sand. In some places the surface layer and subsoil are coarser textured. In other places the underlying material is sand.

Typically, the Storden soil has a surface layer of dark grayish brown loam about 10 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown loam. In some places the surface layer is darker. In other places the soil is sandy loam throughout.

Included with these soils in mapping are small areas of Delft, Nicollet, Terril, and Webster soils. The poorly drained Delft and Webster soils and the moderately well drained Nicollet soils are in the lower landscape positions. The moderately well drained Terril soils are on foot slopes. Included soils make up about 10 percent of the mapped areas.

Permeability is moderate in the Clarion and Storden soils. It is moderately rapid in the upper part of the Estherville soil and rapid in the lower part. Surface runoff is medium on the Clarion and Storden soils and slow on the Estherville soil. Reaction is medium acid to mildly alkaline in the surface layer and subsoil of the Clarion soil, mildly alkaline or moderately alkaline throughout the Storden soil, and medium acid to neutral in the surface layer and subsoil of the Estherville soil. The available water capacity is high in the Clarion and Storden soils and low in the Estherville soil. Organic matter content is moderate in the Clarion and Estherville soils and low in the Storden soil.

Most areas are used as cropland. The most common crops are corn and soybeans. These soils are fairly well suited to cultivated crops. Water erosion is the main hazard. Also, the Estherville soil is droughty. It is best suited to small grain and other crops that mature before the droughty period late in the growing season. Applying tillage methods that leave crop residue on the surface, contour stripcropping, and terraces help to control runoff and erosion. Contour stripcropping and terraces are used where slopes are long and smooth.

These soils are suited to the trees and shrubs grown as windbreaks and environmental plantings. The droughtiness of the Estherville soil restricts the number of species suitable for planting. Because soil conditions vary, onsite investigation is needed to determine the proper species for planting. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIIe.

920C—Clarion-Estherville-Storden complex, 6 to 12 percent slopes. These sloping, well drained soils are on knolls on till plains. Individual areas are irregular in shape and range from 5 to 30 acres in size. They are about 40 percent Clarion soil, 25 percent Estherville soil, and 25 percent Storden soil. The three soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Clarion soil has a surface layer of very dark grayish brown loam about 9 inches thick. The subsoil is dark yellowish brown loam about 18 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and light olive brown loam. In places free lime is at or near the surface.

Typically, the Estherville soil has a surface layer of very dark gray sandy loam about 10 inches thick. The subsoil is about 15 inches thick. It is dark brown. The upper part is sandy loam, and the lower part is gravelly coarse sand. The underlying material to a depth of about 60 inches is brown gravelly coarse sand. In some places the surface layer and subsoil are coarser textured. In other places the underlying material is sand.

Typically, the Storden soil has a surface layer of dark grayish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is light yellowish brown and yellowish brown loam. In some places the surface layer is darker. In other places the soil is sandy loam throughout.

Included with these soils in mapping are small areas of Delft, Nicollet, Terril, and Webster soils. The poorly drained Delft and Webster soils and the moderately well drained Nicollet soils are in the lower landscape positions. The moderately well drained Terril soils are on foot slopes. Included soils make up about 10 percent of the mapped areas.

Permeability is moderate in the Clarion and Storden soils. It is moderately rapid in the upper part of the Estherville soil and rapid in the lower part. Surface runoff is medium on the Clarion and Storden soils and slow on the Estherville soil. Reaction is medium acid to mildly alkaline in the surface layer and subsoil of the Clarion soil, mildly alkaline or moderately alkaline throughout the Storden soil, and medium acid to neutral in the surface layer and subsoil of the Estherville soil. The available water capacity is high in the Clarion and Storden soils and low in the Estherville soil. Organic matter content is moderate in Clarion and Estherville soils and low in the Storden soil.

Most areas are used as cropland. The most common crops are corn and soybeans. These soils are poorly suited to cultivated crops. Water erosion is the main hazard. Also, the Estherville soil is droughty. It is best suited to small grain and other early maturing crops. Excessive runoff reduces the amount of moisture available for crop production. Applying tillage methods that leave crop residue on the surface, contour stripcropping, and terracing help to control runoff and erosion. Contour stripcropping and terraces are used where slopes are long and smooth.

These soils are suited to the trees and shrubs grown as windbreaks and environmental plantings. The droughtiness of the Estherville soil restricts the number of species suitable for planting. Because soil conditions vary, onsite investigation is needed to determine the proper species for planting. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IVe.

921B2—Clarion-Storden loams, 3 to 6 percent slopes, eroded. These gently sloping, well drained soils are on slightly convex knolls on till plains. Individual areas are irregular in shape and range from 5 to 30 acres in size. They are about 60 percent Clarion soil and 30 percent Storden soil. The two soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Clarion soil has a surface layer of very dark gray loam about 10 inches thick. The subsoil is loam about 15 inches thick. The upper part is brown, and the lower part is dark yellowish brown. The underlying material to a depth of about 60 inches is yellowish brown loam. In places free lime is at or near the surface.

Typically, the Storden soil has a surface layer of dark grayish brown loam about 10 inches thick. The underlying material to a depth of about 60 inches is loam. It is yellowish brown in the upper part and light olive brown in the lower part. In places the surface layer is darker.

Included with these soils in mapping are small areas of Delft, Terril, and Webster soils. The poorly drained Delft and Webster soils are in the lower landscape positions. The moderately well drained Terril soils are on foot slopes. Also included are small pockets of sand and gravel. Included soils make up about 10 percent of the mapped areas.

Permeability is moderate in the Clarion and Storden soils. Surface runoff is medium. Reaction is medium acid to mildly alkaline in the surface layer and subsoil of the Clarion soil and mildly alkaline or moderately alkaline throughout the Storden soil. The available water capacity is high in both soils. Organic matter content is moderate in the Clarion soil and low in the Storden soil.

Most areas are used as cropland. The most common crops are corn and soybeans. These soils are well suited to cultivated crops. Water erosion is the main hazard. Erosion and runoff can be controlled by contour stripcropping and terracing where slopes are long and smooth and by applying tillage methods that leave crop residue on the surface where slopes are short and irregular.

These soils are suited to the trees and shrubs grown as windbreaks and environmental plantings. The Storden soil has a high content of lime, which limits the number of species suitable for planting. Because soil conditions vary, onsite investigation is needed to determine the proper species for planting. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIe.

921C2—Clarion-Storden loams, 6 to 12 percent slopes, eroded. These sloping, well drained soils are on

knolls on till plains (fig. 4). Individual areas are irregular in shape and range from 5 to 30 acres in size. They are about 50 percent Clarion soil and 40 percent Storden soil. The two soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Clarion soil has a surface layer of very dark grayish brown loam about 10 inches thick. The subsoil is dark yellowish brown loam about 16 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loam. In places free lime is at or near the surface.

Typically, the Storden soil has a surface layer of dark grayish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is yellowish brown and light olive brown loam. In places the surface layer is darker or is sandy loam.

Included with these soils in mapping are small areas of Delft, Terril, and Webster soils. The poorly drained Delft and Webster soils are in the lower landscape positions. The moderately well drained Terril soils are on foot slopes. Also included are small pockets of sand and gravel. Included soils make up about 10 percent of the mapped areas.

Permeability is moderate in the Clarion and Storden soils. Surface runoff is medium. Reaction is medium acid to mildly alkaline in the surface layer and subsoil of the Clarion soil and mildly alkaline or moderately alkaline throughout the Storden soil. The available water capacity is high in both soils. Organic matter content is moderate in the Clarion soil and low in the Storden soil.

Most areas are used as cropland. The most common crops are corn and soybeans. These soils are fairly well suited to cultivated crops. Water erosion is the main hazard. Excessive runoff reduces the amount of moisture available for crop production. Erosion and runoff can be controlled by contour stripcropping and terracing where slopes are long and smooth and by applying tillage

Figure 4.—An area of Clarion-Storden loams, 6 to 12 percent, eroded, adjacent to a farm pond.

methods that leave crop residue on the surface where slopes are short and irregular.

These soils are suited to the trees and shrubs grown as windbreaks and environmental plantings. The Storden soil has a high content of lime, which limits the number of species suitable for planting. Because soil conditions vary, onsite investigation is needed to determine the proper species for planting. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIIe.

923E—Copaston-Rock outcrop complex, 0 to 40 percent slopes. This nearly level to very steep map unit occurs as areas of a well drained, shallow Copaston soil intermingled with outcrops of bedrock. The outcrops are Sioux quartzite and granite. Some areas in the valley of the Minnesota River are subject to flooding. Individual areas are irregular in shape and range from 4 to 50 acres in size. They are about 50 percent Copaston soil and 40 percent Rock outcrop. The Copaston soil and Rock outcrop occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Copaston soil has a surface layer of black loam about 12 inches thick. The subsurface layer is very dark gray loam about 4 inches thick. Sioux quartzite bedrock is at a depth of about 16 inches. In places the depth to bedrock is more than 20 or less than 12 inches.

Included with the Copaston soil and Rock outcrop in mapping are small areas of Tilfer Variant and Ves soils. The poorly drained, moderately deep Tilfer Variant soils are in the lower landscape positions. Ves soils are deep. Included soils make up about 10 percent of the mapped areas.

Permeability is moderate in the Copaston soil. Surface runoff is slow or medium. The surface soil is medium acid to neutral. The available water capacity is very low or low. Organic matter content is moderate or high.

Most areas are used as pasture or woodland. Because of the outcrops of bedrock and the low or very low available water capacity in the Copaston soil, this map unit is generally unsuitable as cropland and is poorly suited to pasture and woodland. Several areas along the Minnesota River support native hardwoods. The most common trees are American elm, basswood, ironwood, sugar maple, and bur oak. Because of the slope, the outcrops, and the droughtiness, establishing seedlings is difficult.

The land capability classification is VIIs.

929—Fieldon-Canisteo complex. These nearly level, poorly drained soils are on low flats on outwash plains and ground moraines. Individual areas are irregular in shape and range from 10 to 200 acres in size. They are about 50 percent Fieldon soil and 35 percent Canisteo soil. The two soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Fieldon soil has a surface layer of black loam about 10 inches thick. The subsurface layer is very dark gray loam about 10 inches thick. The subsoil is grayish brown fine sandy loam about 11 inches thick. The upper part of the underlying material is grayish brown fine sand. The lower part to a depth of about 60 inches is grayish brown, mottled loamy fine sand. In some places the surface layer is leached of lime. In other places the dark surface soil is more than 24 inches thick.

Typically, the Canisteo soil has a surface soil of black clay loam about 17 inches thick. The subsoil is light olive gray, mottled clay loam about 11 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled clay loam. In some areas the surface layer is leached of lime. In other areas the dark surface soil is more than 24 inches thick.

Included with these soils in mapping are small areas of Lemond, Nicollet, and Spicer soils. The poorly drained Lemond and Spicer soils are in landscape positions similar to those of the Fieldon and Canisteo soils. Lemond soils are coarser textured in the underlying material than the Fieldon and Canisteo soils. Spicer soils are finer textured than the Fieldon and Canisteo soils. The moderately well drained Nicollet soils are in the higher landscape positions. Included soils make up about 15 percent of the mapped areas.

Permeability is moderate in the upper part of the Fieldon soil and moderately rapid in the lower part. It is moderate in the Canisteo soil. Surface runoff is slow on both soils. Reaction is mildly alkaline or moderately alkaline throughout the profile. The available water capacity is moderate in the Fieldon soil and high in the Canisteo soil. Organic matter content is high in both soils. A seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. These soils are well suited to cultivated crops. The wetness is the main limitation. A subsurface drainage system generally is needed before the soils can be cropped intensively. Tile drains can lower the water table and thus allow the soils to dry to a proper moisture content for tillage. A high content of lime results in a fertility imbalance. It restricts the availability of essential plant nutrients, particularly phosphorus. Crops and crop varieties that are tolerant of the high content of lime should be selected for planting.

These soils are well suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of the high content of lime and the excess moisture. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIw.

946—Dickman-Nicollet complex. These nearly level, moderately well drained soils are on low knolls on

outwash plains and ground moraines. Individual areas are irregular in shape and range from 5 to 60 in size. They are about 45 percent Dickman soil and 40 percent Nicollet soil. The two soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Dickman soil has a surface layer of very dark gray sandy loam about 10 inches thick. The subsurface layer is very dark grayish brown sandy loam about 4 inches thick. The subsoil is about 20 inches thick. The upper part is dark yellowish brown loamy sand, and the lower part is light olive brown, mottled sand. The underlying material to a depth of about 60 inches is light brownish gray, mottled sand. In places it is gravelly.

Typically, the Nicollet soil has a surface layer of black loam about 10 inches thick. The subsurface layer is very dark gray loam about 6 inches thick. The subsoil is loam about 13 inches thick. The upper part is dark brown, and the lower part is olive brown and mottled. The underlying material to a depth of about 60 inches is grayish brown, mottled loam. In places the surface layer is sandy loam. In some areas free lime is at or near the surface. In other areas the subsoil is very dense.

Included with these soils in mapping are small areas of Hanska, Linder, and Webster soils. The poorly drained Hanska and Webster soils are in the lower landscape positions. The moderately well drained Linder soils are in landscape positions similar to those of the Dickman and Nicollet soils. They have gravelly underlying material. Included soils make up about 15 percent of the mapped areas.

Permeability is moderate in the Nicollet soil. It is moderately rapid in the upper part of the Dickman soil and rapid in the lower part. Surface runoff is slow on both soils. Reaction is medium acid to neutral in the surface soil and subsoil of the Dickman soil and medium acid to mildly alkaline in the surface soil and subsoil of the Nicollet soil. The available water capacity is high in the Nicollet soil and low in the Dickman soil. Organic matter content is moderate in the Dickman soil and high in the Nicollet soil. A seasonal high water table is at a depth of 3.0 to 6.0 feet in the Dickman soil and 2.5 to 5.0 feet in the Nicollet soil.

Most areas are used as cropland. The most common crops are small grain and soybeans. These soils are fairly well suited to cultivated crops. The Dickman soil is droughty during years of low rainfall. Also, it is subject to wind erosion. Applying tillage methods that leave crop residue on the surface or planting field windbreaks helps to control wind erosion and conserves moisture.

These soils are suited to the trees and shrubs grown as windbreaks and environmental plantings. Because of the low available water capacity in the Dickman soil, the trees and shrubs that are tolerant of droughty conditions should be selected for planting. Wind erosion on the Dickman soil can damage seedlings. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIIs.

954B2—Ves-Storden loams, 2 to 6 percent slopes, eroded. These gently sloping, well drained soils are on knolls on ground moraines. Individual areas are irregular in shape and range from 3 to 30 acres in size. They are about 60 percent Ves soil and 30 percent Storden soil. The two soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Ves soil has a surface layer of very dark gray loam about 10 inches thick. The subsoil is dark yellowish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is light olive brown and light yellowish brown loam. In places free lime is at or near the surface. In some areas the lower part of the subsoil has no accumulations of lime.

Typically, the Storden has a surface layer of dark grayish brown loam about 8 inches thick. The underlying material to a depth of about 60 inches is loam. It is light yellowish brown in the upper part and light olive brown in the lower part. In places the surface layer is darker. In a few areas the soil is sandy loam throughout.

Included with these soils in mapping are small areas of Delft, Terril, and Webster soils. The poorly drained Delft and Webster soils are in the lower landscape positions. The moderately well drained Terril soils are on foot slopes. Also included are small pockets of sand and gravel. Included soils make up about 10 percent of the mapped areas.

Permeability is moderate in the Ves and Storden soils. Surface runoff is medium. Reaction is slightly acid to moderately alkaline in the surface layer and subsoil of the Ves soil and is mildly alkaline throughout the Storden soil. The available water capacity is high in both soils. Organic matter content is moderate in the Ves soil and low in the Storden soil.

Most areas are used as cropland. The most common crops are corn and soybeans. These soils are well suited to cultivated crops. Water erosion is the main hazard. Erosion and runoff can be controlled by contour stripcropping and terracing where slopes are long and smooth and by applying tillage methods that leave crop residue on the surface where slopes are short and irregular.

These soils are suited to the trees and shrubs grown as windbreaks and environmental plantings. The Storden soil has a high content of lime, which limits the number of species suitable for planting. Because soil conditions vary, onsite investigation is needed to determine the proper species for planting. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIe.

954C2—Ves-Storden loams, 6 to 12 percent slopes, eroded. These sloping, well drained soils are on

knolls on ground moraines. Individual areas are irregular in shape and range from 3 to 30 acres in size. They are about 50 percent Ves soil and 40 percent Storden soil. The two soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Ves soil has a surface layer of very dark grayish brown loam about 9 inches thick. The subsoil is dark yellowish brown loam about 11 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loam. In some places free lime is at or near the surface. In other places the lower part of the subsoil has no accumulations of lime.

Typically, the Storden soil has a surface soil of dark grayish brown loam about 10 inches thick. The underlying material to a depth of about 60 inches is loam. It is yellowish brown in the upper part and light olive brown in the lower part. In places the surface layer is darker. In a few areas the soil is sandy loam throughout.

Included with these soils in mapping are small areas of Delft, Terril, and Webster soils. The poorly drained Delft and Webster soils are in the lower landscape positions. The moderately well drained Terril soils are on foot slopes. Also included are small pockets of sand and gravel. Included soils make up about 10 percent of the mapped areas.

Permeability is moderate in the Ves and Storden soils. Surface runoff is medium. Reaction is slightly acid to moderately alkaline in the surface layer and subsoil of the Ves soil and is mildly alkaline or moderately alkaline throughout the Storden soil. The available water capacity is high in both soils. Organic matter content is moderate in the Ves soil and low in the Storden soil.

Most areas are used as cropland. The most common crops are corn and soybeans. These soils are fairly well suited to cultivated crops. Water erosion is the main hazard. Excessive runoff reduces the amount of moisture available for crop production. Erosion and runoff can be controlled by contour stripcropping and terracing where slopes are long and smooth and by applying tillage methods that leave crop residue on the surface where slopes are short and irregular.

These soils are suited to the trees and shrubs grown as windbreaks and environmental plantings. The Storden soil has a high content of lime, which limits the number of species suitable for planting. Because soil conditions vary, onsite investigation is needed to determine the proper species for planting. Cultivation and applications of herbicide help to remove competing plants. Erosion is a hazard. It can be controlled by limiting site preparation to the area within 2 feet of the seedling.

The land capability classification is IIIe.

954D2—Storden-Ves loams, 12 to 18 percent slopes, eroded. These moderately steep, well drained soils are on knolls on ground moraines. Individual areas are irregular in shape and range from 5 to 30 acres in size. They are about 50 percent Storden soil and 40 percent Ves soil. The two soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Storden soil has a surface layer of dark brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is loam. It is light yellowish brown in the upper part and yellowish brown in the lower part. In some places the surface layer is darker. In other places the soil is sandy loam throughout.

Typically, the Ves soil has a surface layer of very dark gray loam about 9 inches thick. The subsoil is dark yellowish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is loam. It is light yellowish brown in the upper part and yellowish brown in the lower part. In some places free lime is at or near the surface. In other places the lower part of the subsoil has no accumulations of lime.

Included with these soils in mapping are small areas of the poorly drained Delft soils in narrow drainageways and the moderately well drained Terril soils on foot slopes. Also included are small pockets of sand and gravel. Included soils make up about 10 percent of the mapped areas.

Permeability is moderate in the Storden and Ves soils. Surface runoff is rapid. Reaction is slightly acid to moderately alkaline in the surface layer and subsoil of the Ves soil and is mildly alkaline or moderately alkaline throughout the Storden soil. The available water capacity is high in both soils. Organic matter content is moderate in the Ves soil and low in the Storden soil.

Most areas are used as cropland. The most common crops are corn and soybeans. These soils are poorly suited to cultivated crops. Water erosion is the major hazard. Excessive runoff reduces the amount of moisture available for crop production. Erosion and runoff can be controlled by contour stripcropping and terracing where slopes are long and smooth and by applying tillage methods that leave crop residue on the surface where slopes are short and irregular.

These soils are suited to the trees and shrubs grown as windbreaks and environmental plantings. The Storden soil has a high content of lime, which limits the number of species suitable for planting. Because soil conditions vary, onsite investigation is needed to determine the proper species for planting. Erosion is a hazard. It can be controlled by limiting site preparation to the area within 2 feet of the seedling. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IVe.

960D2—Storden-Clarion loams, 12 to 18 percent slopes, eroded. These moderately steep, well drained soils are on knolls on ground moraines. Individual areas are irregular in shape and range from 5 to 30 acres in size. They are about 50 percent Storden soil and 40 percent Clarion soil. The two soils occur as areas so

intricately mixed that separating them in mapping is not practical.

Typically, the Storden soil has a surface layer of dark grayish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is loam. It is yellowish brown in the upper part and light olive brown in the lower part. In places the surface layer is darker. In a few areas the soil is sandy loam throughout.

Typically, the Clarion soil has a surface layer of very dark grayish brown loam about 10 inches thick. The subsoil is dark yellowish brown loam about 8 inches thick. The underlying material to a depth of about 60 inches is light olive brown loam. In places free lime is at or near the surface.

Included with these soils in mapping are small areas of the poorly drained Delft soils in narrow drainageways and the moderately well drained Terril soils on foot slopes. Also included are small pockets of sand and gravel. Included soils make up about 10 percent of the mapped areas.

Permeability is moderate in the Storden and Clarion soils. Surface runoff is rapid. Reaction is medium acid to mildly alkaline in the surface layer and subsoil of the Clarion soil and is mildly alkaline or moderately alkaline throughout the Storden soil. The available water capacity is high in both soils. Organic matter content is moderate in the Clarion soil and low in the Storden soil.

Most areas are used as cropland. The most common crops are corn and soybeans. These soils are poorly suited to cultivated crops. Water erosion is the major hazard. Excessive runoff reduces the amount of moisture available for crop production. Erosion and runoff can be controlled by contour stripcropping and terracing where slopes are long and smooth and by applying tillage methods that leave crop residue on the surface where slopes are short and irregular.

These soils are suited to the trees and shrubs grown as windbreaks and environmental plantings. The Storden soil has a high content of lime, which limits the number of species suitable for planting. Because soil conditions vary, onsite investigation is needed to determine the proper species for planting. Erosion is a hazard. It can be controlled by limiting site preparation to the area within 2 feet of the seedling. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IVe.

968—Hanska-Webster complex. These nearly level, poorly drained soils are on low flats on valley trains and till plains. Individual areas are irregular in shape and range from 10 to 200 acres in size. They are about 50 percent Hanska soil and 40 percent Webster soil. The two soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Hanska soil has a surface layer of black sandy loam about 10 inches thick. The subsurface layer also is black sandy loam. It is about 8 inches thick. The subsoil is about 24 inches thick. The upper part is dark grayish brown, mottled sandy loam, and the lower part is grayish brown, mottled loamy sand. The underlying material to a depth of about 60 inches is light brownish gray sand. In some places it is gravelly. In other places free lime is at or near the surface. Some areas are subject to ponding.

Typically, the Webster soil has a surface soil of black loam about 16 inches thick. The subsoil is olive clay loam about 10 inches thick. The underlying material to a depth of about 60 inches is light olive gray, mottled clay loam. In some places free lime is at or near the surface. In other places the dark surface soil is more than 24 inches thick. In some areas the surface layer is sandy loam. In a few areas the subsoil is very dense.

Included with these soils in mapping are small areas of Dickman and Glencoe soils. The moderately well drained Dickman soils are in the higher landscape positions. The very poorly drained Glencoe soils are in depressions and are subject to ponding. Included soils make up about 10 percent of the mapped areas.

Permeability is moderately rapid in the upper part of the Hanska soil and rapid in the lower part. It is moderate in the Webster soil. Surface runoff is slow on both soils. The surface layer and subsoil are slightly acid to mildly alkaline. The available water capacity is moderate in the Hanska soil and high in the Webster soil. Organic matter content is high in both soils. A seasonal high water table is at a depth of 1 to 3 feet in the Hanska soil and 1 to 2 feet in the Webster soil.

Most areas are used as cropland. The most common crops are corn and soybeans. These soils are well suited to cultivated crops. The wetness is the main limitation. A subsurface drainage system generally is needed before the soils can be cropped intensively. Tile drains can lower the water table and thus allow the soils to dry to a proper moisture content for tillage.

These soils are well suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of excess moisture. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIw.

999B—Ves-Storden-Estherville complex, 2 to 6 percent slopes. These gently sloping, well drained soils are on knolls on ground moraines. Individual areas are irregular in shape and range from 5 to 40 acres in size. They are about 50 percent Ves soil, 20 percent Storden soil, and 20 percent Estherville soil. The three soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Ves soil has a surface layer of very dark gray loam about 13 inches thick. The subsoil is dark yellowish brown loam about 17 inches thick. The underlying material to a depth of about 60 inches is

yellowish brown and light olive brown loam. In places free lime is at or near the surface.

Typically, the Storden soil has a surface layer of dark grayish brown loam about 8 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loam. In some places the surface layer is darker. In other places the soil is sandy loam throughout.

Typically, the Estherville soil has a surface layer of very dark grayish brown sandy loam about 11 inches thick. The subsoil is dark yellowish brown sandy loam about 6 inches thick. The underlying material to a depth of about 60 inches is yellowish brown gravelly coarse sand. In some places the surface layer and subsoil are coarser textured. In other places the underlying material is sand.

Included with these soils in mapping are small areas of Delft, Terril, and Webster soils. The poorly drained Delft and Webster soils are in the lower landscape positions. The moderately well drained Terril soils are on foot slopes. Included soils make up about 10 percent of the mapped areas.

Permeability is moderate in the Ves and Storden soils. It is moderately rapid in the upper part of the Estherville soil and rapid in the lower part. Surface runoff is slow on the Estherville soil and medium on the Ves and Storden soils. Reaction is slightly acid to moderately alkaline in the surface layer and subsoil of the Ves soil, mildly alkaline or moderately alkaline throughout the Storden soil, and medium acid to neutral in the surface layer and subsoil of the Estherville soil. The available water capacity is high in the Ves and Storden soils and low in the Estherville soil. Organic matter content is moderate in the Ves and Estherville soils and low in the Storden soil.

Most areas are used as cropland. The most common crops are corn and soybeans. These soils are fairly well suited to cultivated crops. The main hazard is water erosion. Also, the Estherville soil is droughty. Erosion and runoff can be controlled by contour stripcropping and terracing where slopes are long and smooth and by applying tillage methods that leave crop residue on the surface where slopes are short and irregular.

These soils are suitable for the trees and shrubs grown as windbreaks and environmental plantings. A high content of lime in the Storden soil and the low available water capacity of the Estherville soil limit the number of species suitable for planting. Because soil conditions vary, onsite investigation is needed to determine the proper species for planting. Cultivation or applications of herbicide help to remove competing plants.

The land capability classification is IIIe.

999C—Ves-Storden-Estherville complex, 6 to 12 percent slopes. These sloping, well drained soils are on knolls on ground moraines. Individual areas are irregular in shape and range from 5 to 30 acres in size. They are about 40 percent Ves soil, 30 percent Storden soil, and 20 percent Estherville soil. The three soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Ves soil has a surface layer of very dark gray loam about 10 inches thick. The subsoil is dark yellowish brown loam about 16 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loam. In places free lime is at or near the surface.

Typically, the Storden soil has a surface layer of dark grayish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is loam. It is light yellowish brown in the upper part and yellowish brown in the lower part. In some places the surface layer is darker. In other places the soil is sandy loam throughout.

Typically, the Estherville soil has a surface layer of very dark gray sandy loam about 10 inches thick. The subsoil is dark brown sandy loam about 5 inches thick. The underlying material to a depth of about 60 inches is yellowish brown gravelly coarse sand. In some places the surface layer and subsoil are coarser textured. In other places the underlying material is sand.

Included with these soils in mapping are small areas of Delft, Terril, and Webster soils. The poorly drained Delft and Webster soils are in the lower landscape positions. The moderately well drained Terril soils are on foot slopes. Included soils make up about 10 percent of the mapped areas.

Permeability is moderate in the Ves and Storden soils. It is moderately rapid in the upper part of the Estherville soil and rapid in the lower part. Surface runoff is medium on all three soils. Reaction is slightly acid to moderately alkaline in the surface layer and subsoil of the Ves soil, mildly alkaline or moderately alkaline throughout the Storden soil, and medium acid to neutral in the surface layer and subsoil of the Estherville soil. The available water capacity is high in the Ves and Storden soils and low in the Estherville soil. Organic matter content is moderate in the Ves and Estherville soils and low in the Storden soil.

Most areas are used as cropland. The most common crops are corn and soybeans. These soils are poorly suited to cultivated crops. The main hazard is water erosion. Also, the Estherville soil is droughty. Excessive runoff reduces the amount of water available for crop production. Erosion and runoff can be controlled by contour stripcropping and terracing where slopes are long and smooth and by applying tillage methods that leave crop residue on the surface where slopes are short and irregular.

These soils are suited to the trees and shrubs grown as windbreaks and environmental plantings. A high content of lime in the Storden soil and the low available water capacity in the Estherville soil restrict the number of species suitable for planting. Because soil conditions vary, onsite investigation is needed to determine the

proper species for planting. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IVe.

999D—Storden-Ves-Hawick complex, 12 to 18 percent slopes. These moderately steep, well drained soils are on knolls on ground moraines. Individual areas are irregular in shape and range from 5 to 30 acres in size. They are about 40 percent Storden soil, 30 percent Ves soil, and 20 percent Hawick soil. The three soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Storden soil has a surface layer of dark grayish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loam. In some places the surface layer is darker. In other places the soil is sandy loam throughout.

Typically, the Ves soil has a surface layer of very dark gray loam about 10 inches thick. The subsoil is dark yellowish brown loam about 9 inches thick. The underlying material to a depth of about 60 inches is loam. It is light brown in the upper part and yellowish brown in the lower part. In places free lime is at or near the surface.

Typically, the Hawick soil has a surface layer of very dark grayish brown loamy sand about 10 inches thick. The subsoil is dark brown loamy sand about 6 inches thick. The underlying material to a depth of about 60 inches is yellowish brown gravelly coarse sand. In some places the surface layer is finer textured. In other places the underlying material is sand.

Included with these soils in mapping are small areas of the poorly drained Delft soils in narrow drainageways and the moderately well drained Terril soils on foot slopes. Included soils make up about 10 percent of the mapped areas.

Permeability is moderate in the Ves and Storden soils and very rapid in the Hawick soil. Surface runoff is rapid on the Ves and Storden soils and medium on the Hawick soil. Reaction is slightly acid to moderately alkaline in the surface layer and subsoil of the Ves soil, mildly alkaline or moderately alkaline throughout the Storden soil, and slightly acid to mildly alkaline in the surface layer and subsoil of the Hawick soil. The available water capacity is high in the Ves and Storden soils and low in the Hawick soil. Organic matter content is moderate in the Ves soil, low in the Storden soil, and low or moderate in the Hawick soil.

Most areas are pastured. Some are used as cropland. These soils are poorly suited to cultivated crops. Water erosion is the major hazard. Also, the Hawick soil is droughty. Excessive runoff reduces the amount of moisture available for crop production. Erosion and runoff can be controlled by contour stripcropping and terracing where slopes are long and smooth and by applying tillage methods that leave crop residue on the surface where slopes are short and irregular.

These soils are suitable for the trees and shrubs grown as windbreaks and environmental plantings. A high content of lime in the Storden soil and the low available water capacity in the Hawick soil restrict the number of species suitable for planting. Because soil conditions vary, onsite investigation is needed to determine the proper species for planting. Because of the moderately steep slope, erosion is a hazard. It can be controlled by limiting site preparation to the area within 2 feet of the seedling. Cultivation or applications of herbicide help to remove competing plants.

The land capability classification is IVe.

999F—Storden-Hawick complex, 18 to 50 percent slopes. These steep and very steep soils are on knolls in the uplands and on side slopes in stream valleys. The excessively drained Hawick soil is on the upper parts of the landscape, and the well drained Storden soil is on the lower parts. Individual areas are elongated and range from 5 to 50 acres in size. They are about 60 percent Storden soil and 30 percent Hawick soil. The two soils occur as areas so intricately mixed that separating them in mapping is impractical.

Typically, the Storden soil has a surface layer of dark grayish brown loam about 8 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loam. In places the surface layer is coarser textured.

Typically, the Hawick soil has a surface layer of dark brown loamy coarse sand about 11 inches thick. The subsoil is dark yellowish brown gravelly coarse sand about 10 inches thick. The underlying material to a depth of about 60 inches is yellowish brown gravelly coarse sand. In some places the dark brown surface layer is thinner. In other places the soil does not have a dark surface layer.

Included with these soils in mapping are small areas of Sparta and Terril soils. The excessively drained Sparta soils formed in sandy sediments on the upper part of the side slopes. The moderately well drained Terril soils are on foot slopes. Included soils make up about 10 percent of the mapped areas.

Permeability is moderate in the Storden soil and very rapid in the Hawick soil. Surface runoff is rapid on both soils. Reaction is mildly alkaline or moderately alkaline throughout the Storden soil and slightly acid to mildly alkaline in the surface layer and subsoil of the Hawick soil. The available water capacity is high in the Storden soil and low in the Hawick soil. Organic matter content is low in the Storden soil and low or moderate in the Hawick soil.

Most areas are used as woodland or pasture. These soils are unsuitable as cropland because of the slope. They are fairly well suited to woodland. The most common trees are American elm, basswood, ironwood, sugar maple, bur oak, and green ash. The hazard of erosion and the slope are the main management concerns. The hazard of erosion is severe if the surface

is disturbed. In most areas trees cannot be planted by machine because of the slope. The side slopes that face north and east are better sites for many trees and shrubs than the south- and west-facing slopes, which are warmer and drier.

These soils are suitable for the trees and shrubs grown as windbreaks and environmental plantings. The low available water capacity in the Hawick soil restricts the number of species suitable for planting. Because soil conditions vary, onsite investigation is needed to determine the proper species for planting. Erosion is a hazard. It can be controlled by limiting site preparation to the area within 2 feet of the seedling. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is VIIe.

1016—Udorthents, loamy. These soils are in reclaimed gravel or clay pits, borrow pits, and sanitary landfills. Individual areas are irregular in shape and range from 3 to 100 acres in size.

Topsoil generally is stockpiled prior to mining and returned to the site following mining. The topsoil that is returned varies in depth and composition. The underlying material varies from area to area. Soil properties, such as permeability, runoff, the available water capacity, reaction, organic matter content, and the depth to a seasonal high water table, also vary. They can be determined by onsite investigation.

Some areas are farmed. Manipulation by earth-moving equipment has destroyed the natural structure of the topsoil. Onsite investigation is needed to determine the suitability for agricultural crops.

No land capability classification is assigned.

1027—Udorthents, wet substratum. These soils are in areas where heterogeneous fill material was placed on poorly drained and very poorly drained, mineral or organic soils as sites were prepared for buildings, roads, recreation facilities, and other structures. Individual areas range from 2 to 80 acres in size.

The fill is more than 2 feet. The source of the fill material varies. Miscellaneous earthy fill makes up about 80 percent of the unit. The rest is nonsoil material, such as dredged material, bricks, trash, wire, metal, boards, industrial waste, pieces of concrete, or stones, or occurs as small areas of soils that have not been significantly altered by filling.

Soil properties, such as permeability, runoff, the available water capacity, reaction, organic matter content, and the depth to a seasonal high water table, vary. They should be ascertained by onsite investigation.

Many areas are almost totally covered with buildings, asphalt, concrete, or other impervious material. In some areas that are underlain by organic material, settling is a problem. It can hinder maintenance of streets, sidewalks, and pipelines. The organic material should be completely removed before the depression is filled. The ease of establishing and maintaining vegetation varies, depending on the properties of the fill. Detailed onsite investigation is needed to determine the suitability for any proposed use and the limitations affecting that use.

No land capability classification is assigned.

1029—Pits, gravel. This map unit consists of open excavations from which sand and gravel are being or have been removed. The shape and size of the pits vary, depending on the quantity and quality of the material being removed. The bottom of some of the deeper pits is ponded. Many of the pits have been abandoned. They support trees, shrubs, and grasses.

The pits are generally within areas of Estherville, Hawick, Linder, or Ridgeport soils. The surface material has been stripped away and has been used as topsoil or piled around the edge of the pit. Gravel and coarse sand have been removed, leaving an open pit.

The abandoned pits are well suited to wildlife habitat. Pits that can be leveled are fairly well suited or poorly suited to crops and pasture and are well suited or fairly well suited to wildlife habitat and recreational development. Because of a wide range of soil characteristics, onsite investigation is needed to determine the suitability for a specific use.

The land capability classification is VIIIs.

1052—Okoboji and Palms soils, ponded. These nearly level, very poorly drained soils are in undrained, closed depressions that are frequently ponded after rains. Cattails, reeds, sedges, and other water-tolerant plants grow in most areas. There are a few small areas of open water. Individual areas are irregular in shape and range from 3 to 300 acres in size.

Typically, the Okoboji soil is black silty clay loam to a depth of about 60 inches. The surface layer is about 13 inches thick, and the subsurface layer is about 16 inches thick. In some areas the soil has less clay.

Typically, the Palms soil has a surface soil of black muck about 23 inches thick. The underlying material to a depth of about 60 inches is black silty clay loam. In places the muck is less than 16 inches thick.

Included with these soils in mapping are small areas of Blue Earth, Canisteo, and Hanska soils. The very poorly drained Blue Earth soils formed in coprogenous earth. The poorly drained Canisteo soils are on the rims of the depressions. The very poorly drained Hanska soils are underlain by sand and gravel. Also included are small, nearly level to sloping areas that are seepy. Included soils make up less than 25 percent of the mapped areas.

Permeability is moderately slow in the Okoboji soil. It is moderate in the organic part of the Palms soil and moderate or moderately slow in the underlying material. Reaction is neutral to moderately alkaline in the surface soil of the Okoboji soil and strongly acid to mildly alkaline in the organic part of the Palms soil. The

available water capacity is high or very high in both soils. Organic matter content is very high. The seasonal high water table is 3 feet above to 1 foot below the surface.

Most areas are used as wildlife habitat. These soils are well suited to wetland wildlife habitat (fig. 5). They are unsuitable as cropland, pasture, and woodland because of the ponding.

The land capability classification is VIIIw.

1829B—Ridgeport Variant loam, 0 to 6 percent slopes. This moderately deep, nearly level and gently sloping, well drained soil is on plane or slightly convex slopes on valley trains and stream terraces. Individual areas are irregular in shape and range from 5 to 80 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsoil is about 16 inches thick. The upper part is dark brown coarse sandy loam, and the lower part is dark yellowish brown gravelly sand. Interbedded sandstone and shale bedrock is at a depth of about 25 inches. In many areas numerous stones and boulders are on the surface and in the loamy mantle. In many places a thin layer of cemented ironstone is at the contact between the coarse textured alluvium and the bedrock. In places the bedrock crops out.

Included with this soil in mapping are small areas of Estherville, Linder, and Tilfer Variant soils. The somewhat excessively drained Estherville and moderately well drained Linder soils are in landscape positions similar to those of the Ridgeport Variant soil. They are underlain by sand and gravel. The poorly drained Tilfer Variant soils are in the lower landscape positions. Also included are areas where the soil is underlain by igneous and metamorphic bedrock or by red or green shale and areas where the depth to bedrock is less than 20 inches. Included soils make up 5 to 15 percent of the mapped areas.

Permeability is moderately rapid in the Ridgeport Variant soil. Surface runoff is slow. The surface layer and subsoil are medium acid to mildly alkaline. The available water capacity is moderate. Organic matter content is medium.

Figure 5.—An area of Okoboji and Palms soils, ponded. This area provides good habitat for wetland wildlife.

Most areas are used as cropland. The most common crops are small grain and soybeans. In areas that do not have boulders on the surface, this soil is fairly well suited to cultivated crops. In areas that have numerous boulders on the surface, however, it is poorly suited because the stones interfere with tillage. Droughtiness can limit crop production during years of low rainfall.

This soil is suited to the trees and shrubs grown as windbreaks and environmental plantings. The moderate depth to bedrock and the limited available water capacity, however, restrict the number of species suitable for planting. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIe.

1829C—Ridgeport Variant loam, 6 to 15 percent slopes. This moderately deep, sloping and moderately steep, well drained soil is on convex slopes on valley trains and stream terraces. Individual areas are irregular in shape and range from 5 to 25 acres in size.

Typically, the surface layer is very dark gray loam about 9 inches thick. The subsoil is about 20 inches thick. The upper part is dark brown sandy loam, and the lower part is dark yellowish brown gravelly coarse sand. Interbedded sandstone and shale bedrock is at a depth of about 29 inches. In some areas numerous stones and boulders are on the surface and in the loamy mantle. In other areas a thin layer of cemented ironstone is at the contact between the coarse textured alluvium and the bedrock. In places the bedrock crops out.

Included with this soil in mapping are small areas of Estherville and Hawick soils. These soils are in landscape positions similar to those of the Ridgeport Variant soil. They are underlain by sand and gravel. Also included are areas where the depth to bedrock is less than 20 inches and areas where the soil is underlain by igneous and metamorphic bedrock or by red or green shale. Included soils make up 5 to 15 percent of the mapped areas.

Permeability is moderately rapid in the Ridgeport Variant soil. Surface runoff is medium. The surface layer and subsoil are medium acid to mildly alkaline. The available water capacity is moderate. Organic matter content is medium.

Most areas are used as pasture. Some are used as cropland. This soil is poorly suited to cultivated crops. Water erosion and droughtiness are the main management concerns. Applying tillage methods that leave crop residue on the surface, contour stripcropping, and terracing help to control runoff and erosion. Droughtiness limits crop production during years of low rainfall. The numerous boulders on the surface in some areas interfere with tillage.

This soil is suited to the trees and shrubs grown as windbreaks and environmental plantings. The moderate depth to bedrock and the limited available water capacity, however, restrict the number of species suitable for planting. Cultivation or applications of herbicide help to remove competing plants.

The land capability classification is IVe.

1833—Coland loam. This nearly level, poorly drained soil is on low flats on flood plains. It is occasionally flooded. Individual areas generally are elongated and range from 3 to 320 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is black clay loam about 36 inches thick. The underlying material to a depth of about 60 inches is black loam. In places lime is at or near the surface.

Included with this soil in mapping are small areas of Hanlon, Kalmarville, and Spillville soils. The moderately well drained Hanlon and Spillville soils are in the slightly higher landscape positions. The poorly drained Kalmarville soils are in landscape positions similar to those of the Coland soil. They are coarser textured than the Coland soil. Also included are areas where the soil is underlain by sand and gravel at a depth of 40 inches or more and areas of rock outcrops. Inclusions make up 2 to 10 percent of the mapped areas.

Permeability is moderate in the Coland soil. Surface runoff is slow. The surface soil is slightly acid or neutral. The available water capacity and organic matter content are high. A seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. The wetness and the hazard of flooding following heavy rains and snowmelt are the main management concerns. Drainage tile generally is effective in reducing the wetness, but drainage outlets are not available in many areas.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of the excess moisture and the flooding. Untimely flooding can result in seedling mortality. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIw.

1887—Millington clay loam, sandy substratum. This nearly level, poorly drained soil is on low flats on flood plains. It is occasionally flooded. Individual areas are irregular in shape and range from 3 to 75 acres in size.

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer is about 32 inches thick. The upper part is black clay loam, the next part is black loam, and the lower part is very dark grayish brown sandy loam. The underlying material to a depth of about 60 inches is olive gray, mottled sand. In some places it is gravelly coarse sand. In other places the surface layer is leached of lime.

Included with this soil in mapping are small areas of the moderately well drained Spillville soils in the slightly higher landscape positions. These soils make up 0 to 5 percent of the mapped areas.

Permeability is moderate in the upper part of the Millington soil and rapid in the underlying material. Surface runoff is slow. The surface soil is mildly alkaline or moderately alkaline. The available water capacity and organic matter content are high. A seasonal high water table is at a depth of 1 to 2 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. If protected against flooding and adequately drained, this soil is well suited to cultivated crops. In areas along streams that have steep gradients, floodwater can cause scouring of the topsoil unless a permanent vegetative cover is maintained along the streams. Drainage tile is generally effective in reducing the wetness but drainage outlets are not available in many areas. A high content of lime results in a fertility imbalance. It restricts the availability of essential plant nutrients, particularly phosphorus. This imbalance can be corrected by applications of fertilizer. Otherwise, crops that are tolerant of the high content of lime should be selected for planting.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of the high content of lime, the excess moisture, and the flooding. Untimely flooding can result in seedling mortality. Cultivation or applications of herbicide help to remove competing plants.

The land capability classification is IIw.

1909—Lemond loam, depressional. This nearly level, very poorly drained soil is in depressions on valley trains. It is subject to ponding. Individual areas are irregular in shape and range from 3 to 50 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is very dark gray loam about 20 inches thick. The subsoil is grayish brown, mottled sandy loam about 6 inches thick. The upper part of the underlying material is olive gray, mottled loamy sand. The lower part to a depth of about 60 inches is olive gray gravelly coarse sand. In some places glacial till is within 60 inches of the surface. In a few areas a thin layer of muck is at the surface. In a few areas the underlying material is gravelly.

Included with this soil in mapping are small areas of the very poorly drained Blue Earth soils. These soils formed in coprogenous earth. They are in landscape positions similar to those of the Lemond soil. They make up 0 to 5 percent of the mapped areas.

Permeability is moderately rapid in the upper part of the Lemond soil and rapid in the lower part. Surface runoff is ponded. The surface soil and subsoil are mildly alkaline. The available water capacity is moderate. Organic matter content is high or very high. A seasonal high water table is 1.0 foot above to 2.5 feet below the surface.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is fairly well suited to cultivated crops. The wetness is the main limitation. A subsurface drainage system generally is needed before the soil can be cropped intensively. Tile drains can lower the water table and thus allow the soil to dry to a proper moisture content for tillage. A high content of lime results in a fertility imbalance. It restricts the availability of essential plant nutrients, particularly phosphorus. Crops and crop varieties that are tolerant of the high content of lime should be selected for planting.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of the high content of lime and the excess moisture. Untimely ponding of long duration can result in seedling mortality. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIIw.

1911F—Storden-Ridgeport Variant loams, 15 to 50 percent slopes. These steep and very steep, well drained soils are on side slopes in the valley of the Cottonwood River. The Storden soil is on the upper side slopes, and the Ridgeport Variant soil is on the lower ones. Individual areas are elongated and range from 50 to 400 acres in size. They are about 60 percent Storden soil and 25 percent Ridgeport Variant soil. The two soils occur as areas so intricately mixed that separating them in mapping is impractical.

Typically, the Storden soil has a surface layer of dark grayish brown loam about 6 inches thick. The underlying material to a depth of about 60 inches is light olive brown loam. In some places the surface layer is darker. In other places it has no free carbonates.

Typically, the Ridgeport Variant soil has a surface layer of very dark gray loam about 14 inches thick. Below this is interbedded light brownish gray, soft sandstone and gray, soft shale bedrock. In some places the dark surface soil is more than 24 inches thick.

Included with these soils in mapping are small areas of Hawick, Sparta, and Terril soils. The excessively drained Sparta and Hawick soils are on the upper part of the side slopes, where outwash terraces are adjacent to the valley. The moderately well drained Terril soils are on foot slopes. Also included are areas of sandstone bedrock and numerous springs and seepy areas between the Storden and Ridgeport Variant soils. Inclusions make up about 15 percent of the mapped areas.

Permeability is moderate in the Storden soil and moderately rapid in the Ridgeport Variant soil. Surface runoff is rapid on both soils. Reaction is mildly alkaline or moderately alkaline throughout the Storden soil and medium acid to neutral in the surface layer of the

Ridgeport Variant soil. The available water capacity is high in the Storden soil and moderate in the Ridgeport Variant soil. Organic matter content is low in the Storden soil and moderate in the Ridgeport Variant soil.

Most areas are wooded. These soils are generally unsuitable as cropland because of the slope. They are fairly well suited to woodland. The most common trees are American elm, basswood, ironwood, sugar maple, bur oak, and green ash. The hazard of erosion and the slope are the main management concerns. The hazard of erosion is severe if the surface is disturbed. In most areas trees cannot be planted by machine because of the slope. The side slopes that face north and east are better sites for many trees and shrubs than the south- and west-facing slopes, which are warmer and drier.

These soils are generally unsuitable for windbreaks. They are suitable for environmental plantings, but optimum growth and survival rates are unlikely. The slope is the main management concern. Hand planting is generally needed.

The land capability classification is VIIe.

1912—Tilfer Variant clay loam. This moderately deep, nearly level, poorly drained soil is on low flats on stream terraces and valley trains. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer is very dark gray clay loam about 10 inches thick. The subsoil is grayish brown, mottled loam about 12 inches thick. Interbedded gray shale and yellowish brown sandstone bedrock is at a depth of about 32 inches. In some places the soil has thin layers of cemented ironstone or seams of lignite coal. In other places the surface soil is leached of lime.

Included with this soil in mapping are small areas of the poorly drained Lemond soils. These soils are underlain by sand and gravel. They make up 0 to 10 percent of the mapped areas. Also included are areas where the soil is underlain by red or green shale or by igneous and metamorphic bedrock and areas where the soil is leached and is underlain by hard Sioux quartzite bedrock.

Permeability is moderate in the Tilfer Variant soil. Surface runoff is slow. The surface soil and subsoil are mildly alkaline or moderately alkaline. The available water capacity is moderate or high. Organic matter content is high. A seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. The wetness is the main limitation. A subsurface drainage system generally is needed before the soil can be cropped intensively. Tile drains can lower the water table and thus allow the soil to dry to a proper moisture content for tillage. In some areas cemented ironstone layers hinder tile drainage. A high content of lime results in a fertility imbalance. It restricts the availability of essential plant nutrients, particularly phosphorus. Crops and crop varieties that are tolerant of the high content of lime should be selected for planting.

This soil is poorly suited to the trees and shrubs grown as windbreaks and environmental plantings because of the moderate depth to bedrock. The trees and shrubs selected for planting should be those that are tolerant of the high content of lime and the excess moisture. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIw.

1917—Nishna silty clay, ponded. This nearly level, very poorly drained soil is in depressions on flood plains. It is frequently flooded. Individual areas are irregular in shape and range from 3 to 80 acres in size.

Typically, the surface layer is black silty clay about 14 inches thick. The subsurface layer is very dark gray silty clay about 12 inches thick. The underlying material to a depth of about 60 inches is black silty clay. In some places a thin layer of peat is at the surface. In other places the soil has less clay and more sand. In some areas the surface layer is leached of lime. Some areas are not subject to ponding.

Included with this soil in mapping are small areas of the poorly drained Colo soils in the slightly higher landscape positions. These soils make up 0 to 5 percent of the mapped areas.

Permeability is slow in the Nishna soil. Surface runoff is ponded. The soil is mildly alkaline or moderately alkaline throughout. The available water capacity is moderate. Organic matter content is high or very high. The seasonal high water table is 1 foot above to 1 foot below the surface.

Most areas are used as wildlife habitat. This soil is well suited to wetland wildlife habitat. Because of the flooding and the ponding, it is generally unsuited to cultivated crops and to windbreaks and environmental plantings.

The land capability classification is VIw.

1919F—Clarion-Terril loams, 25 to 50 percent slopes. These very steep, well drained soils are on north- and east-facing side slopes in the major stream valleys and ravines. Individual areas are elongated and range from 10 to 800 acres in size. They are about 70 percent Clarion soil and 20 percent Terril soil. The two soils occur as areas so intricately mixed that separating them in mapping is not practical.

Typically, the Clarion soil has a surface layer of black loam about 8 inches thick. The subsurface layer is very dark gray loam about 7 inches thick. The subsoil is yellowish brown loam about 22 inches thick. The underlying material to a depth of about 60 inches is light olive brown loam.

Typically, the Terril soil has a surface layer of black loam about 16 inches thick. The subsurface layer is very dark gray loam about 15 inches thick. The subsoil is dark

brown loam about 15 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown loam. In some places the dark surface soil is more than 36 inches thick. In other places the soil is sandy loam throughout.

Included with these soils in mapping are small areas of the poorly drained Delft soils in drainageways. These included soils make up about 10 percent of the mapped areas.

Permeability is moderate in the Clarion and Terril soils. Surface runoff is rapid. Reaction is medium acid to mildly alkaline in the surface soil and subsoil of the Clarion soil and slightly acid or neutral in the surface soil and subsoil of the Terril soil. The available water capacity and organic matter content are high in both soils.

Most areas are wooded. These soils are generally unsuitable as cropland because of the slope. They are fairly well suited to woodland. The most common trees are American elm, basswood, ironwood, sugar maple, bur oak, and green ash. The hazard of erosion and the slope are the main management concerns. The hazard of erosion is severe if the surface is disturbed. In most areas trees cannot be planted by machine because of the slope. The side slopes that face north and east are better sites for many trees and shrubs than the south- and west-facing slopes, which are warmer and drier.

These soils are poorly suited to windbreaks. They are suitable for environmental plantings, but optimum growth and survival rates are unlikely. The slope is the main management concern. Hand planting is generally needed.

The land capability classification is VIIe.

1928—Hanska loam, gravelly substratum. This nearly level, poorly drained soil is on low flats on valley trains. Individual areas are irregular in shape and range from 3 to 60 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer also is black loam. It is about 8 inches thick. The subsoil is about 13 inches thick. The upper part is dark grayish brown, mottled sandy loam, and the lower part is grayish brown, mottled loamy sand. The underlying material to a depth of about 60 inches is grayish brown, mottled gravelly coarse sand. In some places the loamy mantle is less than 20 inches thick. In other places glacial till is within 60 inches of the surface. In some areas the depth to free lime is more than 60 inches. Some areas are subject to ponding.

Included with this soil in mapping are small areas of the moderately well drained Linder soils in the higher landscape positions. These soils make up 0 to 10 percent of the mapped areas.

Permeability is moderately rapid in the upper part of the Hanska soil and rapid in the underlying sand and gravel. Surface runoff is slow. The surface soil and subsoil are slightly acid to mildly alkaline. The available water capacity is moderate. Organic matter content is high. A seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. The wetness is the main limitation. A subsurface drainage system generally is needed before the soil can be cropped intensively. Tile drains can lower the water table and thus allow the soil to dry to a proper moisture content for tillage.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of excess moisture. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIw.

1929—Lemond loam, gravelly substratum. This nearly level, poorly drained soil is on low flats on valley trains. Individual areas are irregular in shape and range from 3 to 100 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer also is black loam. It is about 8 inches thick. The subsoil is dark grayish brown, mottled sandy loam about 9 inches thick. The underlying material to a depth of about 60 inches is pale olive brown, mottled gravelly coarse sand. In places the loamy mantle is less than 20 inches thick and is coarser textured. In a few areas the underlying material is sand. Some areas are subject to ponding.

Included with this soil in mapping are small areas of Hanska and Linder soils. The very poorly drained Hanska soils are in depressions and are subject to ponding. The moderately well drained Linder soils are in the higher landscape positions. Included soils make up 2 to 10 percent of the mapped areas.

Permeability is moderately rapid in the upper part of the Lemond soil and rapid in the underlying sand and gravel. Surface runoff is slow. The soil is mildly alkaline or moderately alkaline throughout. The available water capacity is moderate. Organic matter content is high. A seasonal high water table is at a depth of 1 to 3 feet.

Most areas are used as cropland. The most common crops are corn and soybeans. This soil is well suited to cultivated crops. The wetness is the main limitation. A subsurface drainage system generally is needed before the soil can be cropped intensively. Tile drains can lower the water table and thus allow the soil to dry to a proper moisture content for tillage. A high content of lime results in a fertility imbalance. It restricts the availability of essential plant nutrients, particularly phosphorus. Crops and crop varieties that are tolerant of the high content of lime should be selected for planting.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of the high content of lime and the excess

moisture. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIw.

1930—Dickman sandy loam, moderately wet. This nearly level, moderately well drained soil is on plane or slightly convex slopes on valley trains and outwash plains. Individual areas are irregular in shape and range from 3 to 80 acres in size.

Typically, the surface soil is black sandy loam about 15 inches thick. The subsoil is about 21 inches thick. The upper part is brown sandy loam, and the lower part is dark yellowish brown sand. The underlying material to a depth of about 60 inches is dark yellowish brown, mottled sand. In places glacial till is within 60 inches of the surface.

Included with this soil in mapping are small areas of the poorly drained Hanska soils in the lower landscape positions. These soils make up 0 to 10 percent of the mapped areas.

Permeability is moderately rapid in the upper part of the Dickman soil and rapid in the lower part. Surface runoff is medium. The surface soil and subsoil are medium acid to neutral. The available water capacity is low. Organic matter content is moderate or high. A seasonal high water table is at a depth of 3 to 6 feet.

Most areas are used as cropland. The most common crops are small grain and soybeans. This soil is fairly well suited to cultivated crops. It is best suited to the crops that mature before the droughty period late in the growing season. Droughtiness can limit production during years of low rainfall. Wind erosion is a problem, and young plants are easily damaged by windblown sand. Applying tillage methods that leave crop residue on the surface or planting field windbreaks helps to control wind erosion and conserves moisture. The soil is well suited to irrigation if an adequate water supply if available.

This soil is suited to the trees and shrubs grown as windbreaks and environmental plantings. The low available water capacity is the main management concern. Also, windblown sand can damage seedlings. The trees and shrubs that are tolerant of droughty conditions should be selected for planting. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIIs.

1931—Essexville sandy loam. This nearly level, poorly drained soil is on lake plains and till plains. Individual areas are elongated and range from 5 to 40 acres in size.

Typically, the surface layer is black sandy loam about 9 inches thick. The subsurface layer is very dark gray loamy sand about 8 inches thick. The subsoil is dark gray loamy sand about 6 inches thick. The underlying material to a depth of about 60 inches is grayish brown and olive gray, mottled clay loam. In places the dark surface soil is more than 24 inches thick.

Included with this soil in mapping are small areas of Canisteo, Hanska, Lemond, and Webster soils. These soils are in landscape positions similar to those of the Essexville soil. Canisteo and Webster soils formed entirely in loamy sediments. Hanska and Lemond soils are underlain by sandy material. Included soils make up 5 to 15 percent of the mapped areas.

Permeability is rapid in the upper part of the Essexville soil and moderately slow in the underlying loamy sediments. Surface runoff is very slow. The surface soil and subsoil are mildly alkaline or moderately alkaline. The available water capacity is moderate. Organic matter content is high. A seasonal high water table is within a depth of 1 foot.

Most areas are used as cropland. Some areas around undrained depressions and lakes are left idle. The most common crops are corn and soybeans. This soil is fairly well suited to cultivated crops. The wetness is the main limitation. A subsurface drainage system generally is needed before the soil can be cropped intensively. Tile drains can lower the water table and thus allow the soil to dry to a proper moisture content for tillage.

This soil is well suited to the trees and shrubs grown as windbreaks and environmental plantings. The trees and shrubs selected for planting should be those that are tolerant of excess moisture. Cultivation and applications of herbicide help to remove competing plants.

The land capability classification is IIIw.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 322,000 acres in the survey area, or nearly 84 percent of the total land area, meets the soil requirements for prime farmland. Areas of this land are throughout the county. The main crops grown on this land are corn and soybeans.

A recent trend in land use in some parts of the county has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify for prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

By Lester H. Schmidt, district conservationist, and David B. Breitbach, conservation agronomist, Soil Conservation Service.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

Approximately 340,000 acres in Brown County was cropland or pasture in 1980. Of a total of 322,000 acres of cropland, about 140,000 acres was used for corn grown for grain or silage; 130,000 acres for soybeans; 27,000 acres for oats, wheat, and other small grain; 17,000 acres for rotation hay; and 8,000 acres for sweet corn and peas grown for canning. In recent years the acreage used for corn and soybeans has increased at the expense of pasture, woodland, and hayland.

On about 20 percent of the cropland, few limitations affect cropping. The soils in these areas are nearly level and are not significantly affected by erosion and runoff or by wetness. They have a sufficient amount of available water for the major crops. An example is Nicollet soils.

About 14 percent of the cropland consists of deep, well drained, gently sloping soils, such as the less sloping Clarion soils, that are subject to runoff and erosion. On many of these soils, a system of conservation tillage that leaves crop residue on or near the surface increases the ability of the soils to absorb runoff and, if a sufficient cover of crop residue is maintained, can keep soil losses within tolerable limits. In some areas a combination of conservation tillage and terraces is needed to reduce the length of slopes and thus control runoff and erosion.

About 50 percent of the cropland consists of wet soils, such as Webster and Glencoe soils. A subsurface drainage system is needed to increase the depth of the root zone in these soils and to provide timely access to all parts of the field. A drainage system that includes open ditches or large tile generally is needed to dispose of the excess water collected from these soils. In many areas additional drainage measures or an improved drainage system is needed. Measures that maintain a high level of fertility, applications of the proper kinds and amounts of herbicide, and conservation tillage also are needed.

About 8 percent of the soils used as cropland are somewhat droughty and are subject to wind erosion (fig. 6). Wind erosion is an especially serious hazard on

Dickman, Estherville, and Dickinson soils. Field windbreaks and conservation tillage conserve moisture and help to prevent excessive soil loss. If an adequate supply of water is available, these soils can be irrigated.

About 5 percent of the cropland consists of sloping and moderately steep Storden and Clarion soils. The amount of soil lost through water erosion is generally high. Conventional tillage methods, especially moldboard plowing in the fall, are not suitable because they can result in excessive soil loss. One of the most effective erosion-control methods on these soils is conservation tillage. The kinds of conservation tillage include full-width tillage; chisel-plow, disc, and strip tillage; till planting on ridges; and no-till planting. The benefits of conservation tillage include erosion control, reduced fuel consumption, and a substantial saving of time. Other beneficial conservation measures on these soils include grassed waterways, water- and sediment-control basins, diversions, and stripcropping. In areas where slopes are long and uniform, terraces, contour farming, and contour stripcropping can be effective in reducing the erosion hazard. Returning crop residue to the soil increases the rate of water infiltration, thus reducing the hazards of runoff and erosion. Some of the steepest areas should be used as permanent pasture or replanted to trees.

About 5 percent of the cropland is on low lying flood plains along streams and rivers. Many of the soils in these areas are highly productive, but they are occasionally or frequently flooded. Calco, Millington, and Kalmarville soils are examples.

About 18,000 acres in the county is used as permanent pasture. This acreage is not cropped because the soils are too steep, are flooded too frequently, or are too wet. Many of the pastures are unmanaged and are overgrazed areas of Kentucky bluegrass. Existing pastures can be improved by applications of fertilizer, pasture rotation, deferment of grazing when the soil is wet, and weed control. In places the pasture can be renovated by reseeding to more productive species. Species selection should be based on the soil type and the drainage conditions.

Figure 6.—Soil deposited in a roadside ditch in an area of Dickman sandy loam, 0 to 2 percent slopes. This soil is subject to wind erosion.

Deep, well drained to somewhat poorly drained soils, such as Clarion, Nicollet, Normania, and Ves soils, are suited to the widest range of plant species. These include alfalfa, birdsfoot trefoil, red clover, smooth bromegrass, timothy, orchardgrass, Kentucky bluegrass, and reed canarygrass. These soils are well suited to warm-season grasses, including big bluestem, indiangrass, and switchgrass, which can be grazed during July and August. The poorly drained Canisteo, Delft, and Webster soils also are well suited to these cool- and warm-season species.

The very poorly drained Blue Earth, Okoboji, and Palms soils are suited only to the species that can withstand wet conditions. Examples are reed canarygrass, creeping foxtail, redtop, birdsfoot trefoil, alsike clover, and ladino clover. If a drainage system is installed, these soils also are suitable for timothy, smooth bromegrass, Kentucky bluegrass, and red clover.

Well drained to excessively drained soils, including Dickinson, Estherville, and Hawick soils, generally produce forage in spring and early summer and again in the fall, when precipitation is adequate. During the summer months, droughty conditions limit production. Alfalfa, red clover, birdsfoot trefoil, smooth bromegrass, orchardgrass, timothy, Kentucky bluegrass, and intermediate wheatgrass grow well if an adequate moisture supply is available. These soils also are well suited to warm-season grasses, including big bluestem, little bluestem, indiangrass, switchgrass, and sideoats grama. If proper grazing management is applied, these species provide good forage during the summer. If grown along with cool-season species, they help to provide a full season of forage production.

Current information about variety selection and species adaptation can be obtained from local offices of the Cooperative Extension Service or the Soil Conservation Service.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table.

Windbreaks and Environmental Plantings

Since the days of the early settlers, windbreaks have been planted to protect farmsteads and livestock. In the 1930's, they were planted to control wind erosion. In recent years field windbreaks have been planted to trap snow and thus increase the moisture supply. Maximum growth and survival rates can be obtained by controlling weeds around newly planted trees and shrubs.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Most of the recreational areas in Brown County are along streams and around lakes. The recreational activities in these areas include hunting, wildlife viewing, fishing, trapping, boating, cross-country skiing, and snowmobiling.

The Minnesota River, the Cottonwood River, and Lake Hanska are the main scenic areas in the county. The Minnesota and Cottonwood Rivers provide interesting canoeing through tree-lined valleys. In most years the flow in the Cottonwood River is sufficient for canoeing after midsummer. Both rivers provide the angler an opportunity to catch northern pike, walleye, catfish, and several species of rough fish. Brown County and other counties along the Minnesota River have developed a land use plan to protect the scenic and recreational values in the valley of the river.

Flandreau State Park, near New Ulm, is 800 acres of flood plains, stream terraces, and side slopes along the Cottonwood River. The park has a swimming pool, camp sites, picnic areas, and a system of trails.

Lake Hanska, in the southeastern part of the county, is 8 miles long and about 0.5 mile wide. On the east end of the lake is a county park, which provides camping facilities, picnic areas, and a boat launch.

Parts of Sleepy Eye Lake have been dredged. A city park that includes a fieldstone shelter is on the north side of the lake. The lake is stocked for fishing and is deep enough for boating.

Several wildlife areas, about 10 small lakes, and 4 small streams provide other opportunities for recreation. Historic sites related to early settlement and the 1862 Indian uprising are in scattered areas throughout the county.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding

and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Kenneth Bonnema, area wildlife manager, Minnesota Department of Natural Resources, helped prepare this section.

The fertile soils in Brown County can support large wildlife populations. Hungarian partridge, pheasants, cottontail rabbits, squirrels, waterfowl, and white-tailed deer are the wildlife species most commonly pursued by hunters.

At one time the county supported a large population of pheasants. Changing agricultural practices over the last two decades have led to a drastic decline in the population of this game bird. Fall plowing has resulted in barren fields that are windswept and hold little snow. Drifting snow covers the available habitat in the winter. As the winter progresses, many of the pheasants die. Drainage of wetlands over the past two decades also has substantially reduced the extent of the habitat for pheasants.

The county has 39 lakes and wetlands 10 acres or more in size. Although these bodies of water are too shallow to support permanent fish populations, they provide fair to excellent waterfowl habitat. Of these lakes and wetlands, 9 are included either wholly or partially within 10 wildlife management areas open to the public for hunting. The 10 wildlife management areas make up 1,804 acres in the county. The most common waterfowl species are mallard, blue-winged teal, wood duck, and Canada geese. Waterfowl populations have been declining steadily over the last two decades. This trend can be expected to continue as drainage of the wetlands and intensified agriculture continue to reduce the acreage of wetland and grassland habitat, which provides important nesting cover.

White-tailed deer are the only big game species in the county. The 1981 deer harvest was approximately 425 animals. An aerial census in January 1982 located approximately 560 deer wintering in the county. The largest concentration was about 230 deer in and around Flandreau State Park. The areas along the Minnesota River, the Cottonwood River, and the Little Cottonwood River provide good to excellent winter habitat for deer. During the summer months, the deer disperse out from the river valleys into the farmland. The deer are in excellent health as a result of the high-quality diet afforded by the agricultural areas. Productivity is high. The average doe bears twin fawns, and some does bear triplets or quadruplets.

Soil-conserving measures that minimize wind erosion and the drifting of snow into areas of wildlife habitat can increase wildlife populations. In areas where field windbreaks have been established, winter losses of wildlife are less severe than in the more open areas of the county.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and

abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, apple, hawthorn, dogwood, blackberry, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer, stone content, soil texture, and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They

have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones

and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to wind erosion.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts,

are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

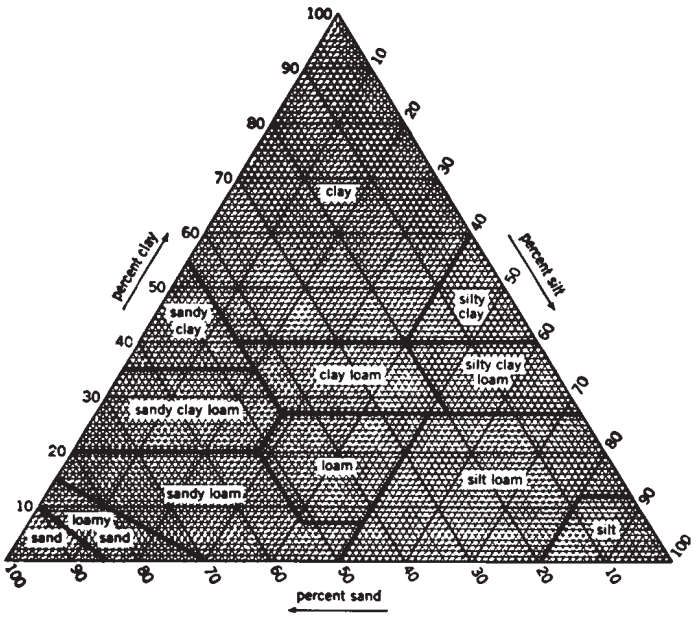


Figure 7.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 7). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of

grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to

buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.
3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.
5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.
6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.
7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.
8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 15, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 16, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table, the kind of water table, and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16. An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 16 shows the total subsidence, which usually is a result of oxidation.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*9*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 17 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquolls (*Hapl*, meaning minimal horizonation, plus *aquoll*, the suborder of the Mollisols that has an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Typic Haplaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the underlying material can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*8*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*9*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Blue Earth Series

The Blue Earth series consists of deep, very poorly drained, moderately permeable soils formed in coprogenous earth. These soils are in depressions and drained lakes on ground moraines. Slopes are 0 to 1 percent.

Typical pedon of Blue Earth mucky silt loam, 1,700 feet west and 600 feet north of the southeast corner of sec. 11, T. 108 N., R. 30 W.

Ap—0 to 10 inches; black (5Y 2/1) mucky silt loam (coprogenous earth), dark gray (5Y 4/1) dry; few fine distinct strong brown (7.5YR 5/8) mottles; weak fine subangular blocky structure; very friable; few

snail shells and fragments of snail shells; violent effervescence; mildly alkaline; abrupt smooth boundary.

C1—10 to 19 inches; black (5Y 2/1) mucky silt loam (coprogenous earth), dark gray (5Y 4/1) dry; common fine distinct strong brown (7.5YR 5/8) mottles; weak medium subangular blocky structure; very friable; many snail shells and fragments of snail shells; violent effervescence; mildly alkaline; gradual smooth boundary.

C2—19 to 40 inches; black (5Y 2/1) mucky silt loam (coprogenous earth), dark gray (5Y 4/1) dry; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; very friable; violent effervescence; mildly alkaline; gradual smooth boundary.

C3—40 to 60 inches; black (5Y 2/1) mucky silt loam (coprogenous earth), dark gray (5Y 4/1) dry; few fine distinct yellowish brown (10YR 5/8) mottles; massive; very friable; strong effervescence; mildly alkaline.

The thickness of the coprogenous earth and the depth to loamy glacial till or glaciolacustrine sediments range from 30 to more than 80 inches. The content of coarse fragments in the coprogenous earth ranges from 0 to 25 percent. These fragments are all snail or clam shells. In some pedons as much as 18 inches of sapric material overlies the coprogenous earth. Reaction is mildly alkaline or moderately alkaline throughout the profile.

The coprogenous earth either has hue of 10YR, 2.5Y, or 5Y, value of 2 to 4, and chroma of 1 or 2 or is neutral in hue and value of 2 or 3. It is silt loam, silty clay loam, or clay loam. The organic matter content ranges from 10 to 30 percent. Some pedons have a 2C horizon. This horizon has hue of 2.5Y or 5Y, value of 3 to 5, and chroma of 1 or 2. It is loam, silt loam, clay loam, or silty clay loam.

Calco Series

The Calco series consists of deep, poorly drained, moderately permeable soils formed in silty alluvium on flood plains. Slopes range from 0 to 2 percent.

Typical pedon of Calco silty clay loam, 1,400 feet west and 1,500 feet north of the southeast corner of sec. 1, T. 110 N., R. 31 W.

Ap—0 to 10 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; moderate fine subangular blocky structure; firm; slight effervescence; mildly alkaline; abrupt smooth boundary.

A1—10 to 25 inches; black (5Y 2/1) silty clay loam, very dark gray (5Y 3/1) dry; weak fine subangular blocky structure; friable; strong effervescence; mildly alkaline; gradual smooth boundary.

A2—25 to 42 inches; very dark gray (5Y 3/1) silt loam, dark gray (5Y 4/1) dry; weak very fine subangular blocky structure; friable; strong effervescence; mildly alkaline; gradual smooth boundary.

Cg—42 to 60 inches; dark olive gray (5Y 3/2) silt loam; massive; friable; strong effervescence; mildly alkaline.

The solum is 30 to 60 inches thick. These soils typically have free carbonates throughout, but some subhorizons below a depth of 24 inches are not effervescent. Reaction is mildly alkaline or moderately alkaline throughout the profile.

The A horizon either has hue of 10YR or 5Y and value of 2 or 3 or is neutral in hue and has value of 2. It is silty clay loam or silt loam. Some pedons have an AC horizon. This horizon has hue of 2.5Y or 5Y or is neutral in hue. It has value of 3 or 4 and chroma of 0 or 1. The Cg horizon has hue of 2.5Y or 5Y or is neutral in hue. It has value of 3 to 6 and chroma of 0 to 2. It is silt loam, silty clay loam, or clay loam below a depth of 40 inches.

Canisteo Series

The Canisteo series consists of deep, poorly drained, moderately permeable soils formed in loamy glacial till on ground moraines. Slopes range from 0 to 2 percent.

Typical pedon of Canisteo clay loam, 2,500 feet south and 1,300 feet west of the northeast corner of sec. 31, T. 110 N., R. 32 W.

Ap—0 to 10 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.

A—10 to 18 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; mildly alkaline; clear smooth boundary.

Bg1—18 to 31 inches; olive gray (5Y 4/2) clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; mildly alkaline; gradual smooth boundary.

Bg2—31 to 42 inches; olive gray (5Y 5/2) loam; few fine distinct yellowish brown (10YR 5/8) mottles; weak fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

Cg—42 to 60 inches; olive gray (5Y 5/2) loam; common fine distinct yellowish brown (10YR 5/8) mottles; massive; friable; about 3 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 50 inches. The mollic epipedon ranges from 14 to 24 inches in thickness. The content of coarse fragments is 2 to 8 percent throughout the profile. The soils are mildly alkaline or moderately alkaline throughout.

The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3. It is clay loam, loam, or silty clay loam. The Bg horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5, and chroma of 1 or 2. It is clay loam, loam, silty clay loam, or sandy loam. The Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 to 4. It is clay loam, loam, or fine sandy loam.

Clarion Series

The Clarion series consists of deep, well drained, moderately permeable soils formed in loamy glacial till on till plains. Slopes range from 1 to 50 percent.

Typical pedon of Clarion loam, 1 to 4 percent slopes, 2,100 feet south and 2,600 feet west of the northeast corner of sec. 34, T. 109 N., R. 32 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; medium acid; abrupt smooth boundary.

A—10 to 15 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; medium acid; clear smooth boundary.

Bw1—15 to 22 inches; dark yellowish brown (10YR 4/4) loam; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; medium acid; gradual smooth boundary.

Bw2—22 to 34 inches; yellowish brown (10YR 5/4) loam; few fine distinct strong brown (7.5YR 5/8) mottles; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; medium acid; clear smooth boundary.

C—34 to 60 inches; light olive brown (2.5Y 5/4) loam; few fine distinct strong brown (7.5YR 5/8) mottles; massive; friable; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 18 to 50 inches. The content of coarse fragments is 2 to 8 percent throughout the profile.

The A and Bw horizons are loam or clay loam. The A horizon has value of 2 or 3 and chroma of 1 or 2. It is medium acid to neutral. The Bw horizon has value of 4 or 5 and chroma of 3 or 4. It is medium acid to mildly alkaline. The C horizon has hue of 10YR or 2.5Y. It is loam or sandy loam. It is mildly alkaline or moderately alkaline.

Coland Series

The Coland series consists of deep, poorly drained, moderately permeable soils formed in loamy alluvium on flood plains. Slopes range from 0 to 2 percent.

Typical pedon of Coland loam, 1,900 feet west and 1,600 feet south of the northeast corner of sec. 6, T. 109 N., R. 33 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

A—10 to 46 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; neutral; gradual smooth boundary.

C—46 to 60 inches; black (N 2/0) loam; massive; friable; neutral.

The solum ranges from 36 to 48 inches in thickness. The depth to free carbonates typically is 48 inches or more. The mollic epipedon is 36 or more inches thick.

The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3. It is loam, clay loam, or silty clay loam. It is slightly acid or neutral. Some pedons have an AC or B horizon. These horizons have hue of 10YR or 5Y or are neutral in hue. They have value of 2 to 4 and chroma of 0 or 1. They are clay loam or silty clay loam. They are slightly acid or neutral. The C horizon is loam or sandy loam. It has hue of 2.5Y or 5Y or is neutral in hue. It has value of 2 to 5 and chroma of 0 or 1. It is slightly acid to mildly alkaline.

Copaston Series

The Copaston series consists of shallow, well drained, moderately permeable soils formed in loamy glacial drift over quartzite or granite bedrock. These soils are on terraces or benches and on uplands. Slopes range from 0 to 25 percent.

Typical pedon of Copaston loam, in an area of Copaston-Rock outcrop complex, 0 to 40 percent slopes, 1,500 feet west and 2,100 feet south of the northeast corner of sec. 31, T. 108 N., R. 35 W.

A1—0 to 12 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky structure; friable; about 1 percent coarse fragments; medium acid; gradual smooth boundary.

A2—12 to 16 inches; very dark gray (10YR 3/1) loam, very dark grayish brown (10YR 3/2) dry; weak medium and fine subangular blocky structure; friable; about 4 percent coarse fragments; medium acid; abrupt smooth boundary.

2R—16 inches; quartzite bedrock.

The thickness of the solum and the depth to bedrock range from 8 to 20 inches. The solum has no free carbonates. It is medium acid to neutral.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam, sandy loam, fine sandy loam, or clay loam. Some pedons have a B horizon. This horizon has hue of 10YR or 7.5YR and value and chroma of 3 or 4. It is loam or sandy loam. The bedrock is quartzite in Stately Township and granite in the valley of the Minnesota River.

Darfur Series

The Darfur series consists of deep, poorly drained soils formed in loamy and sandy glacial outwash and lacustrine sediments on outwash plains. Permeability is moderate in the surface soil and moderately rapid in the subsoil and underlying material. Slopes are 0 to 1 percent.

Typical pedon of Darfur loam, 700 feet north and 1,400 feet east of the southwest corner of sec. 35, T. 108 N., R. 33 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure; friable; neutral; abrupt smooth boundary.

A—10 to 19 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (2.5Y 4/2) dry; weak medium and fine subangular blocky structure; friable; neutral; clear smooth boundary.

Bg—19 to 35 inches; dark grayish brown (2.5Y 4/2) fine sandy loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; very friable; neutral; clear smooth boundary.

Cg1—35 to 43 inches; light olive gray (5Y 6/2) loamy very fine sand; many medium distinct yellowish brown (10YR 5/6) mottles; massive; very friable; slight effervescence; mildly alkaline; gradual smooth boundary.

Cg2—43 to 60 inches; olive gray (5Y 5/2) loamy very fine sand; many medium yellowish brown (10YR 5/6) mottles; massive; very friable; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 20 to 40 inches. The depth to free carbonates ranges from 20 to 70 inches. The mollic epipedon ranges from 14 to 24 inches in thickness. Reaction is slightly acid or neutral in the A horizon, neutral or mildly alkaline in the Bg horizon, and neutral to moderately alkaline in the Cg horizon.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam, fine sandy loam, very fine sandy loam, or sandy clay loam.

The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is dominantly fine sandy loam, loam, or sandy clay loam in the upper part and loamy fine sand, fine sandy loam, or loam in the lower part. Strata of these textures are common, and some pedons have subhorizons of loamy very fine sand, very fine sandy loam, or silt loam.

The Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It is dominantly fine sand, loamy fine sand, loamy very fine sand, or fine sandy loam. Strata of these textures are common, and some pedons have subhorizons of finer textured material. Some pedons have a 2C horizon at a depth of 50 inches or more. This horizon is loam or clay loam glacial till.

Delft Series

The Delft series consists of deep, poorly drained, moderately slowly permeable soils formed in loamy alluvium on ground moraines. Slopes range from 1 to 3 percent.

Typical pedon of Delft clay loam, 1,300 feet east and 800 feet north of the southwest corner of sec. 15, T. 108 N., R. 35 W.

A1—0 to 18 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; weak fine granular structure; friable; about 1 percent coarse fragments; neutral; gradual smooth boundary.

A2—18 to 37 inches; black (5Y 2/1) clay loam, very dark gray (5Y 3/1) dry; weak fine subangular blocky structure; friable; about 1 percent coarse fragments; neutral; gradual smooth boundary.

A3—37 to 48 inches; very dark gray (5Y 3/1) clay loam, dark gray (5Y 4/1) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.

Cg—48 to 60 inches; olive gray (5Y 5/2) clay loam; common fine distinct yellowish brown (10YR 5/8) mottles; massive; friable; about 3 percent coarse fragments; neutral.

The thickness of the solum ranges from 30 to 60 inches. The depth to free carbonates and the thickness of the mollic epipedon range from 24 to 60 inches. The content of coarse fragments ranges from 1 to 5 percent throughout the profile.

The A horizon either has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 2 or 3. It is clay loam, loam, or silty clay loam. It is slightly acid or neutral. Some pedons have a Bg horizon. This horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is loam or clay loam. It is neutral or mildly alkaline. The Cg horizon also is neutral or mildly alkaline. It has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is clay loam, loam, or sandy loam.

Dickinson Series

The Dickinson series consists of deep, well drained soils formed in glacial deposits on stream terraces.

These deposits are loamy in the upper part and sandy in the lower part. Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 6 percent.

Typical pedon of Dickinson sandy loam, 0 to 2 percent slopes, 400 feet north and 400 feet east of the southwest corner of sec. 32, T. 110 N., R. 30 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; medium acid; abrupt smooth boundary.
A—10 to 18 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak medium and fine subangular blocky structure; very friable; strongly acid; clear smooth boundary.
Bw—18 to 24 inches; dark brown (10YR 4/3) sandy loam; weak fine subangular blocky structure; very friable; medium acid; clear smooth boundary.
BC—24 to 40 inches; dark yellowish brown (10YR 4/4) loamy sand; weak fine subangular blocky structure; very friable; slightly acid; clear smooth boundary.
C—40 to 60 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; about 2 percent coarse fragments; medium acid.

The solum ranges from 24 to 50 inches in thickness. The depth to loamy sand or sand ranges from 20 to 42 inches.

The A horizon has value of 2 or 3 and chroma of 1 to 3. It is sandy loam, fine sandy loam, or loam. It is medium acid to neutral. The Bw horizon has value of 3 to 5 and chroma of 2 to 6. It is sandy loam or fine sandy loam. It is strongly acid to slightly acid. The BC horizon is loamy fine sand, loamy sand, fine sand, or sand. The C horizon has value of 4 or 5 and chroma of 3 to 6. It is loamy fine sand, loamy sand, fine sand, or sand. It is medium acid to neutral.

Dickman Series

The Dickman series consists of deep, well drained and moderately well drained soils formed in glacial outwash on valley trains and outwash plains. The glacial outwash is loamy in the upper part and sandy in the lower part. Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 6 percent.

Typical pedon of Dickman sandy loam, 0 to 2 percent slopes, 300 feet north and 1,000 feet east of the southwest corner of sec. 32, T. 110 N., R. 30 W.

Ap—0 to 11 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very friable; medium acid; abrupt smooth boundary.
Bw1—11 to 19 inches; dark brown (10YR 4/3) sandy loam; weak fine subangular blocky structure; very friable; medium acid; clear smooth boundary.
Bw2—19 to 30 inches; dark yellowish brown (10YR 4/4) loamy sand; single grain; loose; about 5 percent coarse fragments; slightly acid; clear smooth boundary.
BC—30 to 42 inches; dark brown (7.5YR 4/4) sand; single grain; loose; about 3 percent coarse fragments; medium acid; clear smooth boundary.
C—42 to 60 inches; yellowish brown (10YR 5/4) sand; single grain; loose; about 2 percent coarse fragments; slight effervescence; neutral.

The thickness of the solum ranges from 30 to 50 inches. The depth to free carbonates is 30 inches or more. The depth to loamy fine sand or coarser textures ranges from 12 to 20 inches. The mollic epipedon ranges from 10 to 20 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam, coarse sandy loam, or fine sandy loam. It is slightly acid or medium acid. The Bw horizon has hue of 7.5YR or 10YR and value and chroma of 3 or 4. It is coarse sandy loam, fine sandy loam, sandy loam, loamy coarse sand, loamy sand, or loamy fine sand. It is medium acid to neutral. The BC horizon is fine sand, coarse sand, or sand. The C horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 5 or 6, and chroma of 3 or 4. It is coarse sand, fine sand, or sand. It is slightly acid to mildly alkaline.

Du Page Series

The Du Page series consists of deep, moderately well drained, moderately permeable soils formed in loamy alluvium on flood plains. Slopes range from 0 to 2 percent.

Typical pedon of Du Page loam, 2,500 feet east and 1,000 feet south of the northwest corner of sec. 21, T. 111 N., R. 32 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.
A1—10 to 33 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; slight effervescence; mildly alkaline; gradual smooth boundary.
A2—33 to 46 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; friable; slight effervescence; mildly alkaline; gradual smooth boundary.

C—46 to 60 inches; very dark gray (10YR 3/1) loam; massive; friable; slight effervescence; mildly alkaline.

The soils typically are calcareous throughout, but some pedons do not have free carbonates in the upper 10 inches. The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or silt loam in the upper part. The lower part of the A horizon and the C horizon are loam, sandy loam, or silt loam. The C horizon has value of 3 or 4 and chroma of 1 or 2.

Essexville Series

The Essexville series consists of deep, poorly drained, soils formed in sandy material underlain by loamy glacial till. These soils are on lake plains and till plains. Permeability is rapid in the upper part of the profile and moderately slow in the lower part. Slopes range from 0 to 2 percent.

Typical pedon of Essexville sandy loam, 2,200 feet south and 900 feet west of the northeast corner of sec. 34, T. 111 N., R. 33 W.

Ap—0 to 9 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very friable; about 3 percent coarse fragments; neutral; abrupt smooth boundary.

A—9 to 17 inches; very dark gray (10YR 3/1) loamy sand, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; very friable; about 5 percent coarse fragments; slight effervescence; neutral; gradual smooth boundary.

Bg—17 to 23 inches; dark gray (10YR 4/1) loamy sand; weak fine subangular blocky structure; loose; about 7 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

2Cg1—23 to 43 inches; grayish brown (2.5Y 5/2) clay loam; common medium faint light olive brown (2.5Y 5/4) mottles; massive; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

2Cg2—43 to 60 inches; olive gray (5Y 5/2) clay loam; common coarse distinct light olive brown (2.5Y 5/6) mottles; massive; firm; about 3 percent coarse fragments; strong effervescence; mildly alkaline.

The depth to the 2C horizon ranges from 18 to 40 inches. The depth to free carbonates ranges from 0 to 10 inches. The content of coarse fragments is 0 to 15 percent in the sandy sediments and 0 to 5 percent in the 2C horizon.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam, loamy sand, or loamy fine sand. The Bg horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 or 2. It is loamy sand or loamy fine sand. Some pedons have a Cg horizon. This horizon has hue of 10YR, value of 4 to 6, and chroma of 1 to 4. It is loamy sand, loamy fine sand, or fine sand. The 2Cg horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 to 4. It is loam or clay loam.

Estherville Series

The Estherville series consists of deep, well drained soils formed in glacial outwash on valley trains. The outwash is loamy in the upper part and sandy and gravelly in the lower part. Permeability is moderately rapid in the loamy mantle and rapid in the underlying sand and gravel. Slopes range from 0 to 12 percent.

Typical pedon of Estherville sandy loam, 0 to 2 percent slopes, 2,400 feet east and 1,000 feet north of the southwest corner of sec. 36, T. 110 N., R. 32 W.

Ap—0 to 11 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; about 5 percent coarse fragments; medium acid; abrupt smooth boundary.

Bw—11 to 16 inches; dark brown (10YR 4/3) sandy loam; weak fine subangular blocky structure; very friable; about 10 percent coarse fragments; medium acid; clear smooth boundary.

2BC—16 to 24 inches; dark brown (7.5YR 4/4) gravelly coarse sand; single grain; loose; about 20 percent coarse fragments; slightly acid; clear smooth boundary.

2C1—24 to 40 inches; brown (10YR 5/3) gravelly coarse sand; single grain; loose; about 25 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

2C2—40 to 60 inches; dark yellowish brown (10YR 4/4) gravelly coarse sand; single grain; loose; about 11 percent coarse fragments; slight effervescence; moderately alkaline.

The thickness of the solum and the depth to free carbonates are 15 to 30 inches. The loamy mantle is 10 to 20 inches thick. The mollic epipedon is 9 to 20 inches thick. The content of coarse fragments ranges from 0 to 15 percent in the loamy mantle and from 10 to 35 percent in the underlying sediments.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam or loam. It is medium acid to neutral. The Bw horizon also is medium acid to neutral. It has hue of 7.5YR or 10YR, value of 3 or 4, and chroma of 2 to 4. It is sandy loam, coarse sandy loam, or loam. The 2C horizon has variegated colors with hue of 7.5YR or 10YR, value of 4 to 7, and chroma of 2 to 6. It is neutral to moderately alkaline.

Fieldon Series

The Fieldon series consists of deep, poorly drained soils formed in loamy and sandy glacial outwash on outwash plains. Permeability is moderate in the upper

part of the profile and moderately rapid in the lower part. Slopes are 0 to 1 percent.

Typical pedon of Fieldon loam, in an area of Fieldon-Canisteo complex, 100 feet south and 2,630 feet east of the northwest corner of sec. 34, T. 108 N., R. 32 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine and medium subangular blocky structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

A—10 to 20 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; very friable; strong effervescence; mildly alkaline; gradual smooth boundary.

Bg—20 to 31 inches; grayish brown (2.5Y 5/2) fine sandy loam; weak fine and medium subangular blocky structure; very friable; strong effervescence; mildly alkaline; gradual smooth boundary.

Cg1—31 to 38 inches; grayish brown (2.5Y 5/2) fine sand; single grain; loose; strong effervescence; mildly alkaline; gradual smooth boundary.

Cg2—38 to 60 inches; grayish brown (2.5Y 5/2) loamy fine sand; common medium distinct light olive brown (2.5Y 5/6) mottles; massive; very friable; strong effervescence; mildly alkaline.

The solum ranges from 20 to 40 inches in thickness. Reaction is mildly alkaline or moderately alkaline throughout the profile. The mollic epipedon is 14 to 24 inches thick.

The A horizon has value of 2 or 3. It is loam, fine sandy loam, very fine sandy loam, or sandy clay loam. The Bg horizon has hue of 10YR, 2.5Y, or 5Y and value of 4 or 5. It has chroma of 1 or 2 in the upper part and 1 to 4 in the lower part. It is dominantly very fine sandy loam, fine sandy loam, sandy clay loam, or loam. Strata of these textures are common. Some pedons have subhorizons of loamy fine sand, loamy very fine sand, or silt loam. The Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 to 4. It is stratified fine sand, loamy fine sand, or fine sandy loam. Some pedons have a 2C horizon at a depth of 40 inches or more. This horizon is loam or clay loam glacial till.

Glencoe Series

The Glencoe series consists of deep, very poorly drained, moderately slowly permeable soils formed in silty and loamy alluvium in depressions on ground moraines. Slopes are 0 to 1 percent.

Typical pedon of Glencoe clay loam, 1,800 feet north and 100 feet east of the southwest corner of sec. 7, T. 109 N., R. 33 W.

Ap—0 to 10 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; weak fine and medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

A1—10 to 28 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak fine and medium subangular blocky structure; friable; neutral; clear smooth boundary.

A2—28 to 38 inches; black (5Y 2/1) clay loam, very dark gray (5Y 3/1) dry; weak fine and medium subangular blocky structure; friable; neutral; clear smooth boundary.

Bg—38 to 51 inches; olive gray (5Y 5/2) clay loam; common medium distinct yellowish brown (10YR 5/8) mottles; massive; friable; about 1 percent coarse fragments; neutral; clear smooth boundary.

Cg—51 to 60 inches; olive gray (5Y 5/2) clay loam; common medium distinct yellowish brown (10YR 5/8) mottles; massive; friable; about 2 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to 60 inches. The mollic epipedon ranges from 24 to 46 inches in thickness. Some pedons have an O horizon, which is as much as 6 inches thick. The content of coarse fragments ranges from 0 to 5 percent in the solum and from 2 to 8 percent in the C horizon.

The A horizon either has hue of 10YR, 2.5Y, or 5Y or is neutral in hue. It has value of 2 or 3. It is clay loam or silty clay loam. It is slightly acid or neutral. The Bg horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is loam, clay loam, or silty clay loam. The Cg horizon has hue of 5Y or 2.5Y, value of 4 to 6, and chroma of 2 to 4. It is loam or clay loam.

Grogan Series

The Grogan series consists of deep, well drained, moderately rapidly permeable soils formed in glaciolacustrine sediments on glacial lake plains. Slopes range from 1 to 6 percent.

Typical pedon of Grogan silt loam, 1 to 6 percent slopes, 2,200 feet east and 800 feet north of the southwest corner of sec. 17, T. 110 N., R. 30 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

A—10 to 14 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

Bw—14 to 26 inches; dark brown (10YR 4/3) silt loam; weak fine and medium subangular blocky structure; friable; neutral; clear smooth boundary.

C1—26 to 38 inches; yellowish brown (10YR 5/4) silt loam; massive; friable; strong effervescence; mildly alkaline; gradual smooth boundary.
C2—38 to 49 inches; brown (10YR 5/3) silt loam; common medium distinct dark yellowish brown (10YR 4/6) mottles; massive; friable; strong effervescence; mildly alkaline; gradual smooth boundary.
C3—49 to 60 inches; pale brown (10YR 6/3) loam; common medium distinct dark yellowish brown (10YR 4/6) mottles; massive; friable; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 40 inches. The mollic epipedon ranges from 10 to 18 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 to 3. It is silt loam or loam. It is slightly acid or neutral. The Bw horizon has value of 4 or 5 and chroma of 3 to 5. It is loam, silt loam, or very fine sandy loam. It is slightly acid to mildly alkaline. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 to 6. It is loam, very fine sandy loam, loamy very fine sand, or silt loam. It is mildly alkaline or moderately alkaline.

Hanlon Series

The Hanlon series consists of deep, moderately well drained, moderately rapidly permeable soils formed in loamy alluvium on flood plains. Slopes range from 0 to 2 percent.

Typical pedon of Hanlon sandy loam, 200 feet east and 600 feet north of the southwest corner of sec. 32, T. 109 N., R. 35 W.

Ap—0 to 10 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; very friable; neutral; abrupt smooth boundary.
A1—10 to 32 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; very friable; neutral; abrupt smooth boundary.
A2—32 to 44 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak very fine and fine subangular blocky structure; very friable; neutral; clear smooth boundary.
Bw—44 to 57 inches; very dark gray (10YR 3/1) sandy loam; weak fine subangular blocky structure; very friable; neutral; clear smooth boundary.
C—57 to 60 inches; very dark grayish brown (10YR 3/2) sandy loam; massive; very friable; neutral.

The solum ranges from 40 to 72 inches in thickness. The depth to free carbonates is 48 inches or more. The mollic epipedon ranges from 40 to 70 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam or fine sandy loam. It is slightly acid or neutral. The Bw horizon has value of 3 or 4 and chroma of 1 or 2. It is sandy loam or fine sandy loam. It is medium acid to neutral. The C horizon has hue of 10YR or 2.5Y, value or 3 or 4, and chroma of 1 or 2. It is loamy sand, sandy loam, or loam. It is neutral or mildly alkaline.

Hanska Series

The Hanska series consists of deep, poorly drained and very poorly drained soils formed in glacial outwash on valley trains. The outwash is loamy in the upper part and sandy in the lower part. Permeability is moderately rapid in the loamy mantle and rapid in the sandy underlying material. Slopes range from 0 to 2 percent.

Typical pedon of Hanska sandy loam, 150 feet north and 2,640 feet east of the southwest corner of sec. 19, T. 108 N., R. 33 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.
A—10 to 16 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; slightly acid; clear smooth boundary.
Bg1—16 to 20 inches; olive gray (5Y 4/2) sandy loam; common medium distinct light olive brown (2.5Y 5/6) mottles; weak very fine subangular blocky structure; friable; neutral; clear smooth boundary.
Bg2—20 to 25 inches; olive gray (5Y 5/2) coarse sandy loam; many medium distinct light olive brown (2.5Y 5/4) mottles; weak very fine and fine subangular blocky structure; friable; about 1 percent coarse fragments; neutral; clear smooth boundary.
2Cg1—25 to 35 inches; grayish brown (2.5Y 5/2) sand; many large distinct light olive brown (2.5Y 5/4) mottles; single grain; loose; about 3 percent coarse fragments; neutral; clear smooth boundary.
2Cg2—35 to 44 inches; olive gray (5Y 5/2) sand; single grain; loose; about 1 percent coarse fragments; neutral; clear smooth boundary.
2Cg3—44 to 60 inches; olive gray (5Y 5/2) sand; single grain; loose; slight effervescence; mildly alkaline.

The solum is 24 to 46 inches thick. It is slightly acid or neutral. The depth to free carbonates is 30 to 55 inches. The mollic epipedon is 12 to 24 inches thick. The coarse-loamy mantle is 20 to 40 inches thick.

The A horizon either has hue of 10YR or 2.5Y or is neutral in hue. It has value of 2 or 3. It is sandy loam, fine sandy loam, or loam. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is sandy loam, coarse sandy loam, or loam. Some pedons

have a 2Bg horizon, which is loamy sand, loamy coarse sand, sand, or coarse sand. The 2Cg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 2 or 3. It is dominantly sand but ranges to gravelly coarse sand. It is neutral or mildly alkaline.

Hanska loam, depressional, is a taxadjunct because the mollic epipedon is more than 24 inches thick. Hanska loam, gravelly substratum, is a taxadjunct because the content of coarse fragments in the underlying material is more than 10 percent. These differences, however, do not alter the usefulness or behavior of the soils.

Hawick Series

The Hawick series consists of deep, excessively drained, very rapidly permeable soils formed in sandy and gravelly glacial outwash on valley trains. Slopes range from 2 to 50 percent.

Typical pedon of Hawick coarse sandy loam, 6 to 15 percent slopes, 200 feet east and 1,900 feet south of the northwest corner of sec. 2, T. 109 N., R. 31 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) coarse sandy loam, dark brown (10YR 3/3) dry; weak fine and very fine subangular blocky structure; very friable; about 5 percent coarse fragments; neutral; clear smooth boundary.

Bw—9 to 16 inches; dark brown (7.5YR 4/4) gravelly coarse sand; single grain; loose; about 10 percent coarse fragments; neutral; clear smooth boundary.

C1—16 to 37 inches; dark yellowish brown (10YR 4/4) gravelly coarse sand; single grain; loose; about 25 percent coarse fragments; slight effervescence; mildly alkaline; gradual smooth boundary.

C2—37 to 60 inches; yellowish brown (10YR 5/4) gravelly coarse sand; single grain; loose; about 25 percent coarse fragments; slight effervescence; mildly alkaline.

The solum ranges from 14 to 30 inches in thickness. It is slightly acid to mildly alkaline. The depth to free carbonates ranges from 0 to 30 inches. The mollic epipedon is 10 to 16 inches thick. Coarse fragments are of mixed lithology. The content of the coarse fragments in the control section is 5 to 35 percent. In subhorizons of some pedons, it is as much as 60 percent.

The A horizon has value of 2 or 3 and chroma of 1 to 3. It is coarse sandy loam, loamy sand, loamy coarse sand, or sandy loam. The Bw horizon has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 3 or 4. It is loamy sand, loamy coarse sand, coarse sand, or the gravelly analogs of these textures. The C horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2 to 6. It is coarse sand, sand, or the gravelly analogs of these textures. It is mildly alkaline or moderately alkaline.

Hoopeston Series

The Hoopeston series consists of deep, moderately well drained soils formed in loamy and sandy glacial outwash on outwash plains. These soils are moderately rapidly permeable in the upper part and rapidly permeable in the underlying material. Slopes range from 0 to 3 percent.

The Hoopeston soils in Brown County are outside the range of the official series because they do not have low-chroma mottles within 6 inches of the mollic epipedon and typically have free carbonates within a depth of 40 inches. These differences, however, do not alter the usefulness or behavior of the soils.

Typical pedon of Hoopeston sandy loam, 1,200 feet east and 350 feet north of the southwest corner of sec. 35, T. 108 N., R. 33 W.

Ap—0 to 10 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; very friable; neutral; abrupt smooth boundary.

A—10 to 15 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; very friable; neutral; gradual smooth boundary.

Bw—15 to 24 inches; olive brown (2.5Y 4/4) fine sandy loam; weak fine and medium subangular blocky structure; very friable; neutral; gradual smooth boundary.

BC—24 to 39 inches; light olive brown (2.5Y 5/4) loamy fine sand; common fine distinct light brownish gray (2.5Y 6/2) mottles; single grain; loose; neutral; clear smooth boundary.

C—39 to 60 inches; light yellowish brown (2.5Y 6/4) loamy fine sand; common medium distinct light brownish gray (2.5Y 6/2) mottles; massive; very friable; slight effervescence; mildly alkaline.

The solum ranges from 20 to 44 inches in thickness. The depth to free carbonates ranges from 20 to 45 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam, fine sandy loam, loam, or loamy fine sand. It is medium acid to neutral. The Bw horizon has value of 4 or 5 and chroma of 3 or 4. It is sandy loam, fine sandy loam, loam, or sandy clay loam. It is slightly acid or neutral. The C horizon has value of 4 to 6 and chroma of 3 to 6. It is loamy sand, sandy loam, or loamy very fine sand. It is slightly acid to mildly alkaline.

Kalmarville Series

The Kalmarville series consists of deep, poorly drained, moderately rapidly permeable soils formed in loamy and sandy alluvium on flood plains. Slopes are 0 to 1 percent.

The Kalmarville soils in Brown County are outside the range of the official series because they have free carbonates between depths of 10 and 20 inches. This difference, however, does not alter the usefulness or behavior of the soils.

Typical pedon of Kalmarville sandy loam, 2,050 feet west and 200 feet south of the northeast corner of sec. 28, T. 111 N., R. 32 W.

A—0 to 15 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; slight effervescence; mildly alkaline; clear smooth boundary.

C—15 to 60 inches; stratified dark grayish brown (10YR 4/2) sandy loam and loamy sand and light brownish gray (10YR 6/2) medium and coarse sand; common medium distinct yellowish brown (10YR 5/6) mottles; single grain and massive; very friable in some parts, loose in others; slight effervescence; mildly alkaline.

These soils typically have free carbonates throughout, but parts of some pedons do not have free carbonates. The A horizon has value of 2 to 4 and chroma of 1 or 2. It is dominantly sandy loam or loam but has coarser textured strata in some pedons. The C horizon has hue of 2.5Y or 10YR, value of 3 to 6, and chroma of 1 to 3. It is sandy loam, loamy sand, sand, coarse sand, or gravelly coarse sand. It is neutral or mildly alkaline.

Lemond Series

The Lemond series consists of deep, poorly drained and very poorly drained soils formed in glacial outwash on valley trains. The outwash is loamy in the upper part and sandy or gravelly in the lower part. Permeability is moderately rapid in the loamy mantle and rapid in the sandy underlying material. Slopes range from 0 to 2 percent.

Typical pedon of Lemond loam, 2,300 feet east and 200 feet south of the northwest corner of sec. 25, T. 109 N., R. 32 W.

Ap—0 to 10 inches; black (N 2/0) loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure; very friable; strong effervescence; mildly alkaline; abrupt smooth boundary.

A—10 to 18 inches; black (N 2/0) sandy loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure; very friable; strong effervescence; mildly alkaline; clear smooth boundary.

Bg—18 to 29 inches; grayish brown (2.5Y 5/2) sandy loam; common medium distinct dark yellowish brown (10YR 4/6) mottles; weak fine subangular blocky structure; very friable; about 2 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

2Cg—29 to 60 inches; light olive gray (5Y 6/2) sand; common medium distinct yellowish brown (10YR 5/6) mottles; single grain; loose; about 3 percent coarse fragments; slight effervescence; mildly alkaline.

The solum and the coarse-loamy mantle range from 20 to 40 inches in thickness. The mollic epipedon ranges from 14 to 24 inches in thickness. Reaction is mildly alkaline or moderately alkaline throughout the profile.

The A horizon either has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 or is neutral in hue and has value of 2 or 3. It is loam, sandy loam, or coarse sandy loam. The B horizon has hue of 2.5Y or 5Y and value of 4 or 5. It has chroma of 1 or 2 if hue is 2.5Y and chroma of 1 to 3 if hue is 5Y. This horizon is dominantly loam, sandy loam, or coarse sandy loam. In some pedons, however, it is loamy sand or loamy coarse sand in the lower part. The 2Cg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 2 to 4. It is sand, coarse sand, loamy sand, loamy coarse sand, or gravelly coarse sand.

Lemond loam, depressional, is a taxadjunct because the mollic epipedon is more than 24 inches thick. This difference, however, does not alter the usefulness or behavior of the soil.

Linder Series

The Linder series consists of deep, moderately well drained soils formed in glacial outwash on valley trains and stream benches. The outwash is loamy in the upper part and sandy and gravelly in the lower part. Permeability is moderately rapid in the loamy mantle and very rapid in the underlying sand and gravel. Slopes range from 0 to 2 percent.

The Linder soils in Brown County are outside the range of the official series because they do not have mottles within 16 inches of the surface and do not have a 2-chroma matrix or 2-chroma mottles directly below the mollic epipedon. These differences, however, do not alter the usefulness or behavior of the soils.

Typical pedon of Linder sandy loam, 1,900 feet north and 1,200 feet east of the southwest corner of sec. 24, T. 109 N., R. 34 W.

Ap—0 to 9 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure; friable; about 1 percent coarse fragments; slightly acid; abrupt smooth boundary.

AB—9 to 13 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak medium and fine subangular blocky structure; very friable; about 2 percent coarse fragments; slightly acid; clear smooth boundary.

Bw—13 to 21 inches; dark yellowish brown (10YR 4/4) sandy loam; weak fine and medium subangular

blocky structure; very friable; about 3 percent coarse fragments; slightly acid; clear smooth boundary.

2C1—21 to 39 inches; dark grayish brown (2.5Y 4/2) gravelly coarse sand; few fine distinct yellowish brown (10YR 5/6) mottles; single grain; about 30 percent coarse fragments; loose; slight effervescence; mildly alkaline; clear smooth boundary.

2C2—39 to 60 inches; grayish brown (2.5Y 5/2) gravelly coarse sand; few fine distinct yellowish brown (10YR 5/6) mottles; single grain; loose; about 30 percent coarse fragments; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 42 inches. The depth to sand and gravel ranges from 18 to 28 inches. The mollic epipedon is 10 to 20 inches thick. Coarse fragments are of mixed lithology. The content of coarse fragments in the underlying sediments ranges from 5 to 50 percent.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam or loam. It is medium acid to neutral. The Bw horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 or 4. It is sandy loam, loamy sand, or sand. It is slightly acid or neutral. The 2C horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 6. It is sand or coarse sand in the fine-earth fraction. It generally is mildly alkaline or moderately alkaline, but in some pedons it is neutral in the upper few inches.

Madelia Series

The Madelia series consists of deep, poorly drained, moderately permeable soils formed in silty glaciolacustrine sediments on glacial lake plains. Slopes range from 0 to 2 percent.

Typical pedon of Madelia silty clay loam, 1,700 feet east and 100 feet north of the southwest corner of sec. 2, T. 109 N., R. 30 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary.

A1—9 to 14 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

A2—14 to 19 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

Bg—19 to 28 inches; dark grayish brown (2.5Y 4/2) silt loam; few fine distinct yellowish brown (10YR 5/8) mottles; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

Cg1—28 to 36 inches; olive gray (5Y 5/2) silt loam; few fine distinct brownish yellow (10YR 6/8) mottles; massive; friable; strong effervescence; mildly alkaline; clear smooth boundary.

Cg2—36 to 60 inches; light olive gray (5Y 6/2) silt loam; common medium distinct brownish yellow (10YR 6/8) mottles; massive; friable; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 40 inches. The solum is silty clay loam or silt loam. The mollic epipedon ranges from 14 to 24 inches in thickness.

The A horizon either has hue of 10YR or is neutral in hue. It has value of 2 or 3. It is slightly acid or neutral. The Bg horizon has hue of 2.5Y or 5Y and value of 4 or 5. It has chroma of 1 or 2 if hue is 2.5Y and chroma of 1 to 3 if hue is 5Y. This horizon is neutral or mildly alkaline. The Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 to 4. It is silt loam, silty clay loam, or loam. It is mildly alkaline or moderately alkaline.

Millington Series

The Millington series consists of deep, poorly drained soils formed in loamy alluvium on flood plains. These soils generally are moderately permeable throughout. The sandy substratum phase, however, is moderately rapidly permeable in the upper part and rapidly permeable in the underlying material. Slopes range from 0 to 2 percent.

Typical pedon of Millington clay loam, 700 feet east and 700 feet north of the southwest corner of sec. 3, T. 108 N., R. 35 W.

Ap—0 to 10 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky structure; friable; strong effervescence; mildly alkaline; abrupt smooth boundary.

A1—10 to 28 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak medium and fine subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual smooth boundary.

A2—28 to 38 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.

Cg1—38 to 50 inches; very dark grayish brown (2.5Y 3/2) loam, grayish brown (2.5Y 5/2) dry; massive; friable; slight effervescence; mildly alkaline; clear smooth boundary.

Cg2—50 to 60 inches; dark grayish brown (2.5Y 4/2) sandy loam; few medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; slight effervescence; mildly alkaline.

The solum ranges from 24 to 40 inches in thickness. Reaction is mildly alkaline or moderately alkaline throughout the profile.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is clay loam, loam, silt loam, or silty clay loam. The Cg horizon has hue of 2.5Y or 5Y, value of 3 to 5, and chroma of 1 to 3. It ranges from sandy loam to silty clay loam. Some pedons have sandy layers below a depth of 40 inches.

Minneiska Series

The Minneiska series consists of deep, moderately well drained, moderately rapidly permeable soils formed in loamy and sandy alluvium on flood plains. Slopes range from 0 to 2 percent.

Typical pedon of Minneiska sandy loam, 3,960 feet north and 1,900 feet east of the southwest corner of sec. 28, T. 112 N., R. 33 W.

Ap—0 to 10 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

C—10 to 60 inches; stratified grayish brown (10YR 5/2) loamy sand and fine sand and dark grayish brown (10YR 4/2) sandy loam and loamy sand; single grain and massive; very friable in some parts, loose in others; slight effervescence; mildly alkaline.

Reaction is mildly alkaline or moderately alkaline throughout the profile. The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam, fine sandy loam, very fine sandy loam, loam, or silt loam. The C horizon has hue of 10YR or 2.5Y, value of 2 to 5, and chroma of 2 or 3. It is stratified silt loam, loam, fine sandy loam, sandy loam, loamy fine sand, loamy sand, fine sand, or sand.

Nicollet Series

The Nicollet series consists of deep, moderately well drained, moderately permeable soils formed in loamy glacial till on ground moraines. Slopes range from 1 to 3 percent.

Typical pedon of Nicollet clay loam, 2,600 feet north and 2,200 feet east of the southwest corner of sec. 10, T. 110 N., R. 31 W.

Ap—0 to 10 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; about 1 percent coarse fragments; medium acid; abrupt smooth boundary.

A—10 to 17 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; about 1 percent coarse fragments; slightly acid; clear smooth boundary.

Bw1—17 to 30 inches; dark grayish brown (2.5Y 4/2) clay loam; weak fine subangular blocky structure; friable; neutral; about 2 percent coarse fragments; clear smooth boundary.

Bw2—30 to 36 inches; olive brown (2.5Y 4/4) clay loam; common fine distinct yellowish brown (10YR 5/6) and common medium distinct olive gray (5Y 5/2) mottles; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.

Cg1—36 to 44 inches; olive (5Y 5/3) clay loam; many coarse distinct yellowish brown (10YR 5/6) and many medium faint light gray (5Y 6/1) mottles; massive; friable; about 4 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

Cg2—44 to 60 inches; light olive brown (2.5Y 5/4) clay loam; many medium distinct olive gray (5Y 5/2) mottles; massive; friable; about 4 percent coarse fragments; slight effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 20 to 48 inches. The content of coarse fragments is 1 to 8 percent throughout the profile. The texture is loam or clay loam throughout the profile.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is medium acid to neutral. The Bw horizon has hue of 10YR or 2.5Y. It has value of 3 or 4 and chroma of 2 or 3 in the upper part and value of 4 or 5 and chroma of 2 to 4 in the lower part. It generally is slightly acid or neutral. In some pedons, however, it is mildly alkaline in the lower part. The C horizon has hue of 2.5Y or 5Y and chroma of 2 to 4. It is mildly alkaline or moderately alkaline.

Nishna Series

The Nishna series consists of deep, poorly drained and very poorly drained, slowly permeable soils formed in silty and clayey alluvium on flood plains. Slopes range from 0 to 2 percent.

Typical pedon of Nishna silty clay, 2,400 feet north and 1,700 feet east of the southwest corner of sec. 22, T. 111 N., R. 32 W.

Ap—0 to 10 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; sticky; slight effervescence; mildly alkaline; abrupt smooth boundary.

A1—10 to 28 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; moderate fine subangular blocky structure; sticky; strong effervescence; mildly alkaline; gradual smooth boundary.

A2—28 to 39 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; sticky; slight effervescence; mildly alkaline; gradual smooth boundary.
C—39 to 60 inches; very dark gray (N 3/0) silty clay, dark gray (N 4/0) dry; massive; very sticky; slight effervescence; mildly alkaline.

The solum ranges from about 24 to 46 inches in thickness. The mollic epipedon ranges from 36 to 60 inches in thickness. Most pedons are mildly alkaline or moderately alkaline throughout and have free carbonates throughout. In some pedons, however, the Ap horizon is leached of carbonates and is neutral.

The A horizon either has hue of 10YR or 5Y or is neutral in hue. It has value of 2 or 3. It is silty clay or silty clay loam. Some pedons have a B horizon. This horizon either has hue of 10YR or 5Y, value of 3, and chroma of 1 or is neutral in hue and has value of 3. The C horizon either has hue of 10YR or 5Y, value of 3 or 4, and chroma of 1 or 2 or is neutral in hue and has value of 3 or 4. It is silty clay or silty clay loam.

Normania Series

The Normania series consists of deep, moderately well drained, moderately permeable soils formed in loamy glacial till on ground moraines. Slopes range from 1 to 3 percent.

Typical pedon of Normania loam, 500 feet north and 300 feet east of the southwest corner of sec. 9, T. 109 N., R. 34 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; about 3 percent coarse fragments; neutral; abrupt smooth boundary.
A—10 to 14 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.
Bw—14 to 27 inches; olive brown (2.5Y 4/4) loam; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.
Bk—27 to 39 inches; light olive brown (2.5Y 5/4) loam; common medium distinct light olive gray (5Y 6/2) mottles; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; violent effervescence; mildly alkaline; clear smooth boundary.
C—39 to 60 inches; light olive brown (2.5Y 5/4) loam; many coarse distinct light olive gray (5Y 6/2) and common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 4 percent coarse fragments; strong effervescence; mildly alkaline.

The solum ranges from 18 to 40 inches in thickness. It typically is loam or clay loam, but a few pedons have subhorizons of sandy clay loam or sandy loam. The depth to free carbonates ranges from 18 to 36 inches. Reaction is slightly acid or neutral in the A and Bw horizons and mildly alkaline or moderately alkaline in the Bk and C horizons. The mollic epipedon is 10 to 20 inches thick. The content of coarse fragments is 3 to 8 percent throughout the profile.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The Bw horizon has hue of 2.5Y or 10YR, value of 3 or 4, and chroma of 2 to 4. The Bk horizon has colors similar to those of the Bw horizon, but it also has value of 5. The C horizon has hue of 2.5Y or 5Y, value of 4 to 6, and chroma of 1 to 4. It is loam or clay loam.

Okoboji Series

The Okoboji series consists of deep, very poorly drained, moderately slowly permeable soils formed in silty alluvium. These soils are in depressions on ground moraines. Slopes are 0 to 1 percent.

Typical pedon of Okoboji silty clay loam, 2,600 feet east and 650 feet south of the northwest corner of sec. 33, T. 111 N., R. 32 W.

Ap—0 to 10 inches; black (N 2/0) silty clay loam, very dark grayish brown (2.5Y 3/2) dry; weak fine and medium subangular blocky structure; friable; slightly acid; abrupt smooth boundary.
A1—10 to 32 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak fine and medium subangular blocky structure; friable; slightly acid; clear smooth boundary.
A2—32 to 42 inches; very dark gray (10YR 3/1) silty clay loam, olive gray (5Y 4/2) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
Bg—42 to 50 inches; olive gray (5Y 5/2) silty clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.
Cg—50 to 60 inches; gray (5Y 5/1) silty clay loam; common medium distinct yellowish red (5YR 5/8) mottles; massive; friable; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 40 to 60 inches. The depth to free carbonates ranges from 30 to 50 inches.

The A horizon has value of 2 or 3. It is silty clay loam, silty clay, silt loam, mucky silty clay loam, or mucky silt loam. It is slightly acid or neutral. The Bg horizon has hue of 2.5 or 5Y, value of 4 or 5, and chroma of 1 or 2. It is neutral or mildly alkaline. The Cg horizon has colors similar to those of the Bg horizon. It is silty clay loam,

loam, or silt loam. It is mildly alkaline or moderately alkaline.

Okoboji muck is a taxadjunct to the series because it has a histic epipedon 8 to 16 inches thick. This difference, however, does not alter the usefulness or the behavior of the soil.

Oshawa Series

The Oshawa series consists of deep, very poorly drained, moderately slowly permeable soils formed in silty and loamy alluvium. These soils are in old oxbows and swales on flood plains. Slopes are 0 to 1 percent.

Typical pedon of Oshawa silty clay loam, 800 feet north and 800 feet west of the southeast corner of sec. 5, T. 109 N., R. 31 W.

A1—0 to 10 inches; black (5Y 2/1) silty clay loam, very dark gray (5Y 3/1) dry; weak fine and very fine granular structure; firm; slight effervescence; mildly alkaline; gradual smooth boundary.

A2—10 to 35 inches; very dark gray (5Y 3/1) clay loam, dark gray (5Y 4/1) dry; weak fine subangular blocky structure; friable; strong effervescence; mildly alkaline; gradual smooth boundary.

Cg1—35 to 49 inches; olive gray (5Y 4/2) loam; common fine distinct dark yellowish brown (10YR 3/4) mottles; massive; friable; strong effervescence; mildly alkaline; gradual smooth boundary.

Cg2—49 to 60 inches; olive gray (5Y 5/2) loam; common fine distinct dark yellowish brown (10YR 3/4) mottles; massive; very friable; slight effervescence; mildly alkaline.

The mollic epipedon ranges from 24 to 48 inches in thickness. The A horizon has value of 2 or 3 and chroma of 1 or 2. It is silty clay loam, clay loam, loam, or silt loam. The Cg horizon either has hue of 2.5Y or 5Y, value of 3 to 5, and chroma of 1 or 2 or is neutral in hue and has value of 3 to 5. It typically is loam, silt loam, silty clay loam, or clay loam, but coarser textured strata are common.

Palms Series

The Palms series consists of deep, very poorly drained soils formed in sapric organic material and in the underlying silty and loamy alluvium. These soils are in depressions on ground moraines. Permeability is moderate in the organic layers and moderately slow in the silty and loamy material. Slopes are 0 to 1 percent.

Typical pedon of Palms muck, 2,200 feet east and 500 feet north of the southwest corner of sec. 19, T. 110 N., R. 32 W.

Op—0 to 10 inches; sapric material, black (10YR 2/1) broken face and rubbed; about 24 percent fiber unrubbed, 2 percent rubbed; weak fine subangular blocky structure; very friable; neutral; abrupt smooth boundary.

Oa—10 to 22 inches; sapric material, black (10YR 2/1) broken face and rubbed; about 28 percent fiber unrubbed, 2 percent rubbed; weak fine subangular blocky structure; very friable; slightly acid; clear smooth boundary.

A1—22 to 26 inches; black (5Y 2/1) mucky silty clay loam, very dark gray (5Y 3/1) dry; weak medium and thick platy structure; friable; neutral; clear smooth boundary.

A2—26 to 47 inches; black (5Y 2/1) silty clay loam, very dark gray (5Y 3/1) dry; massive; firm; neutral; gradual wavy boundary.

C—47 to 60 inches; black (5Y 2/1) silty clay loam, very dark gray (5Y 3/1) dry; massive; firm; slight effervescence; mildly alkaline.

The depth to the silty or loamy material ranges from 16 to 30 inches. The O horizon has hue of 5Y or 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 0 or 1. It is dominantly sapric material. It is slightly acid or neutral. The A and C horizons either have hue of 2.5Y or 5Y, value of 2 to 5, and chroma of 1 or 2 or are neutral in hue and have value of 2 or 3. They are silt loam, silty clay loam, or clay loam. They are neutral or mildly alkaline.

Ridgeport Series

The Ridgeport series consists of deep, somewhat excessively drained soils formed in glacial outwash on alluvial stream benches. The outwash is loamy in the upper part and sandy and gravelly in the lower part. Permeability is moderately rapid in the loamy mantle and very rapid in the underlying sand and gravel. Slopes range from 0 to 2 percent.

Typical pedon of Ridgeport sandy loam, 1,700 feet west and 400 feet north of the southeast corner of sec. 18, T. 109 N., R. 32 W.

Ap—0 to 9 inches; black (10YR 2/1) sandy loam; weak fine and medium subangular blocky structure; friable; neutral; abrupt smooth boundary.

A—9 to 12 inches; black (10YR 2/1) sandy loam; weak fine and medium subangular blocky structure; friable; neutral; clear smooth boundary.

Bw—12 to 23 inches; dark yellowish brown (10YR 4/4) sandy loam; weak fine and medium subangular blocky structure; friable; neutral; clear smooth boundary.

BC—23 to 27 inches; dark yellowish brown (10YR 4/4) coarse sandy loam; weak fine subangular blocky structure; very friable; about 2 percent coarse fragments; neutral; clear smooth boundary.

2C—27 to 60 inches; yellowish brown (10YR 5/4) gravelly coarse sand; single grain; loose; about 20

percent coarse fragments; slight effervescence; mildly alkaline.

The solum is 24 to 40 inches thick. The depth to sand and gravel ranges from 20 to 40 inches. The mollic epipedon is 8 to 20 inches thick. The sand and gravel typically have free carbonates throughout but can be leached in the upper 6 inches.

The A and Bw horizons are sandy loam or fine sandy loam. They are medium acid to neutral. The A horizon has value of 2 or 3 and chroma of 1 or 2. The Bw horizon has hue of 10YR or 7.5YR. It has value and chroma of 3 or 4 in the upper part and value of 3 to 5 and chroma of 3 or 4 in the lower part. Some pedons have a 2B horizon. The 2B and 2C horizons have hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. The 2B horizon is loamy sand, gravelly loamy sand, or gravelly sandy loam. The fine-earth fraction of the 2C horizon is coarse sand, sand, or loamy sand. The content of gravel in this horizon is 5 to 25 percent. This horizon is mildly alkaline or moderately alkaline.

Ridgeport Variant

The Ridgeport Variant consists of moderately deep, well drained, moderately rapidly permeable soils formed in loamy, sandy, and gravelly glacial drift over soft bedrock. These soils are on valley trains and stream terraces. Slopes range from 0 to 50 percent.

Typical pedon of Ridgeport Variant loam, 0 to 6 percent slopes, 1,000 feet east and 1,300 feet north of the southwest corner of sec. 3, T. 108 N., R. 35 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; very friable; about 2 percent coarse fragments; slightly acid; abrupt smooth boundary.

Bw1—9 to 16 inches; dark brown (10YR 4/3) sandy loam; weak fine subangular blocky structure; very friable; about 4 percent coarse fragments; slightly acid; clear smooth boundary.

Bw2—16 to 25 inches; dark yellowish brown (10YR 4/4) gravelly coarse sand; single grain; loose; about 35 percent coarse fragments; slightly acid; abrupt smooth boundary.

2Cr1—25 to 34 inches; light yellowish brown (10YR 6/4) soft sandstone; abrupt smooth boundary.

2Cr2—34 to 60 inches; interbedded white (10YR 8/2) soft sandstone and light olive brown (2.5Y 5/4) soft shale.

The thickness of the solum and the depth to interbedded sandstone and shale range from 10 to 40 inches. The mollic epipedon is 7 to 18 inches thick. The depth to free carbonates ranges from 30 to more than 60 inches.

The A horizon has value of 2 or 3 and chroma of 1 to 3. It is loam or sandy loam. It is medium acid to neutral. The Bw horizon has hue of 7.5YR or 10YR and value and chroma of 3 or 4. It is sandy loam, gravelly sandy loam, loamy sand, gravelly loamy sand, coarse sand, or gravelly coarse sand. It is slightly acid or neutral. The 2Cr horizon is interbedded sandstone, clay, igneous and metamorphic bedrock, or shale. It has hue of 7.5YR, 10YR, or 2.5Y, value of 4 to 8, and chroma of 1 to 8. It is slightly acid to mildly alkaline.

Seaforth Series

The Seaforth series consists of deep, moderately well drained, moderately permeable soils formed in loamy glacial till on ground moraines. Slopes range from 1 to 3 percent.

Typical pedon of Seaforth loam, 2,500 feet west and 2,100 feet south of the northeast corner of sec. 4, T. 109 N., R. 33 W.

Ap—0 to 11 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.

Bk1—11 to 19 inches; brown (10YR 5/3) loam; weak medium and fine subangular blocky structure; friable; about 3 percent coarse fragments; violent effervescence; mildly alkaline; clear wavy boundary.

Bk2—19 to 26 inches; light olive brown (2.5Y 5/4) loam; few fine distinct light brownish gray (2.5Y 6/2) and yellowish brown (10YR 5/8) mottles; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; violent effervescence; mildly alkaline; clear wavy boundary.

C1—26 to 40 inches; light olive brown (2.5Y 5/4) loam; common medium distinct light brownish gray (2.5Y 6/2) and yellowish brown (10YR 5/8) mottles; massive; friable; about 4 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

C2—40 to 60 inches; light olive brown (2.5Y 5/4) loam; many large distinct light brownish gray (2.5Y 6/2) mottles; massive; friable; about 4 percent coarse fragments; strong effervescence; moderately alkaline.

The solum ranges from 16 to 36 inches in thickness. It typically is loam or clay loam, but a few pedons have subhorizons of sandy clay loam or sandy loam. A few pedons do not have free carbonates in the upper 7 inches. The mollic epipedon is 10 to 20 inches thick. The content of coarse fragments is 3 to 8 percent throughout the profile. These soils are mildly alkaline or moderately alkaline throughout.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The Bw horizon has hue of 2.5Y or 10YR, value of 4

or 5, and chroma of 2 to 4. The C horizon has hue of 2.5Y, 5Y, or 10YR, value of 4 or 5, and chroma of 2 to 4.

Sparta Series

The Sparta series consists of deep, excessively drained, rapidly permeable soils formed in sandy glacial outwash on valley trains and stream terraces. Slopes range from 2 to 15 percent.

The Sparta soils in Brown County are outside the range of the official series because they are less acid in the solum and contain free carbonates within a depth of 40 inches. These differences, however, do not alter the usefulness or behavior of the soils.

Typical pedon of Sparta loamy sand, 2 to 6 percent slopes, 1,400 feet west and 1,200 feet north of the southeast corner of sec. 36, T. 109 N., R. 33 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) loamy sand, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; very friable; medium acid; abrupt smooth boundary.

A—10 to 15 inches; very dark grayish brown (10YR 3/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; very friable; slightly acid; clear smooth boundary.

Bw—15 to 38 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; about 1 percent coarse fragments; slightly acid; clear smooth boundary.

C—38 to 60 inches; yellowish brown (10YR 5/4) sand; single grain; loose; about 5 percent coarse fragments; slight effervescence; mildly alkaline.

The solum ranges from 24 to 40 inches in thickness. The upper part of the A horizon has hue of 10YR or 7.5YR, value of 2 or 3, and chroma of 1 or 2. The lower part has hue of 7.5YR or 10YR, value of 3 or 4, and chroma of 2 or 3. This horizon is loamy sand, sand, fine sand, or loamy fine sand. It ranges from strongly acid to neutral. The Bw horizon has hue of 7.5YR or 10YR and value and chroma of 3 to 6. It is fine sand, sand, loamy sand, or loamy fine sand. It is slightly acid to mildly alkaline. The C horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 to 6. It is sand or fine sand. It ranges from slightly acid to moderately alkaline.

Spicer Series

The Spicer series consists of deep, poorly drained, moderately permeable soils formed in silty glaciolacustrine sediments on glaciolacustrine plains and valley trains. Slopes range from 0 to 2 percent.

Typical pedon of Spicer silty clay loam, 1,900 feet west and 1,700 feet north of the southeast corner of sec. 27, T. 109 N., R. 33 W.

Ap—0 to 10 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; violent effervescence; moderately alkaline; abrupt smooth boundary.

A—10 to 23 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; violent effervescence; moderately alkaline; clear smooth boundary.

Bg—23 to 45 inches; grayish brown (2.5Y 5/2) silt loam; common medium distinct yellowish brown (10YR 5/8) mottles; weak fine subangular blocky structure; friable; strong effervescence; mildly alkaline; gradual smooth boundary.

Cg—45 to 60 inches; light brownish gray (2.5Y 6/2) silt loam; common coarse distinct light olive brown (2.5Y 5/6) mottles; massive; friable; strong effervescence; mildly alkaline.

The solum ranges from 25 to 45 inches in thickness. It is silty clay loam or silt loam. The mollic epipedon ranges from 18 to 24 inches in thickness. Reaction is mildly alkaline or moderately alkaline throughout the profile.

The A horizon either has hue of 10YR or is neutral in hue. It has value of 2 or 3. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The Cg horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 1 or 2. It generally is silt loam or silty clay loam but has thin strata of coarser textured material in some pedons.

Spillville Series

The Spillville series consists of deep, moderately well drained, moderately permeable soils formed in loamy alluvium on flood plains. Slopes range from 0 to 2 percent.

Typical pedon of Spillville loam, 400 feet east and 600 feet south of the northwest corner of sec. 35, T. 109 N., R. 35 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; very friable; neutral; abrupt smooth boundary.

A1—10 to 37 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak very fine and fine subangular blocky structure; very friable; neutral; gradual smooth boundary.

A2—37 to 54 inches; very dark gray (10YR 3/1) loam, dark grayish brown (10YR 4/2) dry; weak fine and very fine subangular blocky structure; very friable; neutral; gradual smooth boundary.

C—54 to 60 inches; dark grayish brown (10YR 4/2) sandy loam; few fine faint dark yellowish brown (10YR 4/6) mottles; weak fine and very fine subangular blocky structure; very friable; neutral.

The solum ranges from 30 to 56 inches in thickness. The mollic epipedon ranges from 36 to 60 inches in thickness. The depth to free carbonates is 40 inches or more. Reaction is slightly acid or neutral throughout the profile.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or silt loam. The C horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 1 or 2. It is loam, clay loam, or sandy loam.

Storden Series

The Storden series consists of deep, well drained, moderately permeable soils formed in loamy glacial till on ground moraines. Slopes range from 2 to 60 percent.

Typical pedon of Storden loam, in an area of Storden-Clarion loams, 12 to 18 percent slopes, eroded, 2,200 feet west and 2,540 feet north of the southeast corner of sec. 34, T. 110 N., R. 32 W.

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; weak medium granular structure; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline; abrupt smooth boundary.

C1—10 to 31 inches; yellowish brown (10YR 5/4) loam; weak medium and fine subangular blocky structure; friable; about 5 percent coarse fragments; strong effervescence; mildly alkaline; clear smooth boundary.

C2—31 to 60 inches; light olive brown (2.5Y 5/4) loam; common fine distinct yellowish brown (10YR 5/8) mottles; massive; friable; about 5 percent coarse fragments; strong effervescence; mildly alkaline.

The content of coarse fragments is 2 to 10 percent throughout the profile. The soils are mildly alkaline or moderately alkaline throughout.

The A horizon has value of 4 or 5 and chroma of 2 or 3. Some pedons have a Bw horizon. This horizon has chroma of 3 or 4. It is 4 or less inches thick. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 6.

Terril Series

The Terril series consists of deep, moderately well drained, moderately permeable soils formed in loamy colluvium on foot slopes in the uplands. Slopes range from 2 to 40 percent.

Typical pedon of Terril loam, 6 to 12 percent slopes, 1,800 feet east and 2,100 feet south of the northwest corner of sec. 35, T. 110 N., R. 31 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; about 1 percent coarse fragments; neutral; abrupt smooth boundary.

A1—10 to 19 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; about 1 percent coarse fragments; neutral; clear smooth boundary.

A2—19 to 35 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak fine and medium subangular blocky structure; friable; about 1 percent coarse fragments; neutral; clear smooth boundary.

Bw—35 to 48 inches; dark brown (10YR 4/3) loam; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.

C—48 to 60 inches; light yellowish brown (10YR 6/4) loam; massive; friable; about 4 percent coarse fragments; slight effervescence; mildly alkaline.

The solum ranges from 36 to 60 inches in thickness. It is slightly acid or neutral. The mollic epipedon ranges from 24 to 36 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam, silt loam, or clay loam. The Bw horizon has value of 3 or 4 and chroma of 2 to 4. It is loam or clay loam. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 3 to 5. It is neutral or mildly alkaline. It is dominantly loam or clay loam, but in some pedons it is sandy loam below a depth of 40 inches.

Tilfer Variant

The Tilfer Variant consists of moderately deep, poorly drained, moderately permeable soils formed in loamy glacial drift overlying material weathered from interbedded sandstone and shale. These soils are on valley trains and stream terraces. Slopes range from 0 to 2 percent.

Typical pedon of Tilfer Variant clay loam, 1,000 feet south and 1,700 feet west of the northeast corner of sec. 35, T. 109 N., R. 35 W.

Ap—0 to 10 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; weak very fine granular structure; friable; strong effervescence; moderately alkaline; abrupt smooth boundary.

A—10 to 20 inches; very dark gray (N 3/0) clay loam, dark gray (N 4/0) dry; weak very fine subangular blocky structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.

Bg—20 to 32 inches; grayish brown (2.5Y 5/2) loam; few fine distinct olive yellow (2.5Y 6/8) mottles; weak very fine subangular blocky structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.

2Crg—32 to 60 inches; interbedded gray (5Y 5/1) soft shale and yellowish brown (10YR 5/6) soft sandstone; strong effervescence; moderately alkaline.

The thickness of the solum and the depth to interbedded sandstone and silty shale range from 20 to 40 inches. The mollic epipedon ranges from 14 to 24 inches in thickness. The soils are mildly alkaline or moderately alkaline throughout. They typically have no coarse fragments, but thin layers of cemented ironstone are in the lower part of some pedons.

The A horizon either has hue of 2.5Y or 5Y or is neutral in hue. It has value of 2 or 3. It is clay loam, silty clay loam, or loam. The Bg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 to 3. It is loam or clay loam. The 2Cr horizon has hue of 5Y, value of 4 or 5, and chroma of 1 to 3. The texture of the interbedded layers ranges from fine sand to silty clay.

Ves Series

The Ves series consists of deep, well drained, moderately permeable soils formed in loamy glacial till on ground moraines. Slopes range from 1 to 18 percent.

Typical pedon of Ves loam, 1 to 4 percent slopes, 150 feet south and 150 feet west of the northeast corner of sec. 31, T. 110 N., R. 33 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine granular structure; friable; about 2 percent coarse fragments; neutral; abrupt smooth boundary.

A—9 to 13 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.

Bw1—13 to 18 inches; dark brown (10YR 4/3) loam; moderate fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

Bw2—18 to 24 inches; brown (10YR 5/3) loam; moderate fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

BCk—24 to 36 inches; light olive brown (2.5Y 5/4) loam; massive; friable; about 5 percent coarse fragments; many white accumulations of lime; violent effervescence; moderately alkaline; gradual smooth boundary.

C—36 to 60 inches; light olive brown (2.5Y 5/4) loam; massive; friable; about 5 percent coarse fragments; strong effervescence; moderately alkaline.

The solum ranges from 18 to 45 inches in thickness. It is loam or clay loam. The depth to free carbonates ranges from 14 to 33 inches. The mollic epipedon is 10 to 20 inches thick. The content of coarse fragments is 2 to 8 percent throughout the profile.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is slightly acid or neutral. The Bw horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma or 3 or 4. It is neutral or mildly alkaline. The BCk and C horizons are mildly alkaline or moderately alkaline. The BCk horizon has hue of 2.5Y or 10YR and value of 4 to 6. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 or 4. It is loam or clay loam.

Webster Series

The Webster series consists of deep, poorly drained, moderately permeable soils formed in loamy glacial till on till plains. Slopes range from 0 to 2 percent.

Typical pedon of Webster clay loam, 1,400 feet east and 1,200 feet north of the southwest corner of sec. 22, T. 108 N., R. 34 W.

Ap—0 to 10 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 1 percent coarse fragments; neutral; abrupt smooth boundary.

A—10 to 20 inches; black (N 2/0) clay loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure; friable; about 1 percent coarse fragments; neutral; clear smooth boundary.

Bg1—20 to 26 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; gradual wavy boundary.

Bg2—26 to 35 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak very fine and fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.

Bg3—35 to 42 inches; olive gray (5Y 5/2) loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak very fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.

Cg1—42 to 52 inches; light olive gray (5Y 6/2) loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline; clear smooth boundary.

Cg2—52 to 60 inches; olive gray (5Y 5/2) loam; many medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to 50 inches. The solum is clay loam, silty clay loam, or loam. The content of coarse fragments is 1 to 8 percent throughout the profile.

The A horizon has hue of 10YR or is neutral in hue. It has chroma of 2 or 3. It is slightly acid or neutral. The Bg horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. In some pedons it has free carbonates in the lower part. It is neutral or mildly alkaline. The Cg horizon has hue of 5Y or 2.5Y, value of 4 to 6, and

chroma of 1 to 3. It is loam, sandy loam, or clay loam. It is mildly alkaline or moderately alkaline.

Zumbro Series

The Zumbro series consists of deep, well drained, rapidly permeable soils formed in sandy alluvium on flood plains. Slopes range from 0 to 2 percent.

Typical pedon of Zumbro loamy sand, 2,000 feet east and 900 feet south of the northwest corner of sec. 31, T. 110 N., R. 30 W.

Ap—0 to 10 inches; black (10YR 2/1) loamy sand, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very friable; neutral; abrupt smooth boundary.

A1—10 to 24 inches; black (10YR 2/1) loamy sand, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very friable; neutral; gradual smooth boundary.

A2—24 to 37 inches; very dark grayish brown (10YR 3/2) loamy sand, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; very friable; neutral; gradual smooth boundary.

BA—37 to 44 inches; dark brown (10YR 3/3) loamy sand, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; loose; neutral; gradual smooth boundary.

Bw—44 to 53 inches; dark brown (10YR 4/3) loamy sand; weak fine subangular blocky structure; very friable; neutral; abrupt smooth boundary.

C—53 to 60 inches; grayish brown (10YR 5/2) coarse sand; single grain; loose; strong effervescence; mildly alkaline.

The thickness of solum ranges from 26 to 60 inches. The depth to free carbonates ranges from 20 to 60 inches. The mollic epipedon ranges from 24 to 50 inches in thickness. The content of gravel is 0 to 15 percent in the lower part of the profile.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loamy sand, loamy fine sand, sandy loam, or fine sandy loam. It ranges from medium acid to mildly alkaline. The Bw and C horizons are slightly acid to mildly alkaline. The Bw horizon has value and chroma of 2 to 4. It is sand, fine sand, loamy sand, or loamy fine sand. The C horizon has value of 4 or 5 and chroma of 2 to 5. It is sand, fine sand, or coarse sand.

This page intentionally left blank.

Formation of the Soils

Soils form as a result of the interaction of five factors—parent material, climate, plant and animal life, relief, and time. Climate and plant and animal life are active factors of soil formation. They act on the parent material and slowly change it into a soil that has distinct horizons. Their effects are conditioned by relief and time.

Parent Material

The soils in Brown County formed mainly in glacial till or in material sorted out of the till by the action of water. About 80 percent of the soils formed in till, 15 percent in glacial outwash, and 5 percent in alluvium. On a small acreage the soils formed in coprogeneous earth, organic deposits, or material weathered from sedimentary or crystalline rocks of nonglacial origin.

Climate

The parent material was deposited during a glacial period about 12,000 years ago. The postglacial climate progressively warmed and then stabilized about 5,000 years ago. The warming climate is evidenced by successive vegetation types. The initial postglacial vegetation was a spruce forest. It was replaced by a pine forest and then a deciduous forest. The deciduous forest was replaced by prairie when the climate stabilized.

The present climate is essentially uniform throughout the county. Freezing of the soil in the winter slows the soil-forming processes. Alternate periods of freezing and thawing, especially in the spring, play a role in the development of soil structure. Precipitation during the frost-free period transfers soluble and colloidal material from the upper part of the soil to the lower part. The depth to which free lime has been leached has largely determined the thickness of the solum.

Plant and Animal Life

Under the present climate, the native vegetation in Brown County was prairie grasses that were tall or medium, depending on the soil type, the drainage class, and other site factors. Prairie cordgrass, reedgrass, and sedges grew on wet sites. Bluestem, indiangrass, and sideoats grama grew on the better drained sites. As a result of the prairie vegetation, most of the soils in the county have a dark surface layer. Prairie vegetation and cool temperatures have promoted the accumulation of organic matter in the soils.

Soils that formed under forest vegetation, such as those on the north- and east-facing slopes along the Minnesota River, show considerable profile development. After carbonates are leached in these soils, clay particles are translocated from the A horizon to the B horizon.

Human activities have influenced some of the soil-forming processes. Because of farming, accelerated erosion of the surface layer has occurred in the more sloping areas. The surface layer of some of the well drained soils has become browner and has a reduced content of organic matter because it has been mixed with the subsoil by plowing. Tillage has partially altered the original structure of many soils. Applications of fertilizer have increased the fertility of many soils.

Relief

Through its influence on drainage, aeration, and runoff, relief has important effects on soil formation. The soils in Brown County are nearly level to very steep. Maximum profile development has taken place in the nearly level, poorly drained and very poorly drained soils. Substantial profile development also has occurred in soils that formed under forest vegetation. Very poorly drained soils that formed in depressions have a thick, dark profile because additional surface water collected in these areas. The downward percolation of this water has leached carbonates to a greater depth than is typical in the better drained soils. Soils on steep, south- and west-facing slopes show little evidence of soil formation, mostly because runoff is excessive. The excessive runoff has reduced the amount of water available for the leaching of carbonates.

Time

All of the soils in Brown County are geologically young. The process of soil formation began 12,000 years ago, when the glaciers receded. The soils on flood plains show little evidence of soil formation because the parent material is very young.

This page intentionally left blank.

References

(1) American Association of State Highway and Transportation Officials. 1982. Standard specifications for highway materials and methods of sampling and testing. Ed. 13, 2 vols., illus.

(2) American Society for Testing and Materials. 1985. Standard test method for classification of soils for engineering purposes. ASTM Stand. D 2487.

(3) Dunsmore, Oelerich, and Quade. 1979. Public drainage atlas—Brown County, Minnesota. Mankato State Univ., Dep. of Biol., Limnological Contrib. 10.

(4) Kelley, Leota M. 1966. Early Brown County. Brown Cty. Hist. Soc., 19 pp., illus.

(5) McMiller, P.R., and C.O. Rost. 1951. Soils of Brown County, Minnesota. Univ. of Minn., Agric. Exp. Stn., Misc. Rep. 10, 16 pp., illus.

(6) Matsch, Charles L. 1972. Quaternary geology of southwestern Minnesota. *In* Geology of Minnesota: A centennial volume, pp. 548-560, illus.

(7) Thiel, George A. 1944. The geology and underground waters of southern Minnesota. Minn. Geol. Surv., Bull. 31, 506 pp., illus.

(8) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus.

(9) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

(10) Wright, H.E., Jr. 1972. Quaternary history of Minnesota. *In* Geology of Minnesota: A centennial volume, pp. 515-547, illus.

This page intentionally left blank.

Glossary

Ablation till. Loose, permeable till deposited during the final downwasting of glacial ice. Lenses of crudely sorted sand and gravel are common.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Basal till. Compact glacial till deposited beneath the ice.

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat). Fecal material deposited in water by aquatic organisms.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil

horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan*.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multipled by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the

underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Breaking up a compact subsoil by pulling a special chisel through the soil.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial meltwater. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Valley train. A long, narrow area of glacial outwash confined within a valley by a glacier.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

This page intentionally left blank.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-80 at New Ulm, Minnesota)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	22.3	2.0	12.2	47	-30	0	0.76	0.23	1.18	3	9.0
February---	28.9	8.1	18.5	51	-26	0	.94	.38	1.40	3	9.2
March------	39.6	20.3	30.0	71	-13	23	1.72	.71	2.56	4	10.4
April------	58.6	35.5	47.1	88	16	80	2.30	1.19	3.26	6	2.0
May--------	72.5	46.9	59.7	93	26	316	3.62	1.85	5.16	8	.0
June-------	81.6	56.8	69.2	98	39	576	4.37	2.52	6.00	7	.0
July-------	85.5	61.3	73.4	99	45	725	3.87	1.72	5.71	7	.0
August-----	83.3	58.9	71.1	96	43	654	3.65	2.02	5.08	7	.0
September--	74.5	49.3	61.9	94	29	357	2.61	1.01	3.95	6	.0
October----	63.5	38.9	51.2	89	18	143	1.96	.54	3.11	4	.3
November---	43.5	24.8	34.2	70	-5	6	1.35	.30	2.17	3	4.0
December---	28.8	11.3	20.1	52	-23	0	.87	.32	1.31	3	8.4
Yearly:											
Average--	56.9	34.5	45.7	---	---	---	---	---	---	---	---
Extreme--	---	---	---	100	-31	---	---	---	---	---	---
Total----	---	---	---	---	---	2,880	28.02	22.05	33.64	61	43.3

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-80 at New Ulm, Minnesota)

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 25	May 11	May 22
2 years in 10 later than--	Apr. 20	May 6	May 17
5 years in 10 later than--	Apr. 12	Apr. 27	May 7
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 9	Sept. 27	Sept. 15
2 years in 10 earlier than--	Oct. 14	Oct. 2	Sept. 20
5 years in 10 earlier than--	Oct. 24	Oct. 12	Sept. 29

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-80 at New Ulm, Minnesota)

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	174	145	124
8 years in 10	181	153	131
5 years in 10	195	167	144
2 years in 10	208	182	158
1 year in 10	215	190	165

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
8B	Sparta loamy sand, 2 to 6 percent slopes	410	0.1
8C	Sparta loamy sand, 6 to 15 percent slopes	380	0.1
27A	Dickinson sandy loam, 0 to 2 percent slopes	960	0.2
27B	Dickinson sandy loam, 2 to 6 percent slopes	1,700	0.4
31E	Storden loam, 18 to 24 percent slopes	720	0.2
31F	Storden loam, 24 to 60 percent slopes	1,030	0.3
35	Blue Earth mucky silt loam	1,540	0.4
41A	Estherville sandy loam, 0 to 2 percent slopes	3,870	1.0
41B	Estherville sandy loam, 2 to 6 percent slopes	2,010	0.5
85	Calco silty clay loam	3,010	0.8
86	Canisteo clay loam	40,000	10.3
94B	Terril loam, 2 to 6 percent slopes	1,550	0.4
94C	Terril loam, 6 to 12 percent slopes	240	0.1
102B	Clarion loam, 1 to 4 percent slopes	25,000	6.4
102B2	Clarion loam, 3 to 6 percent slopes, eroded	2,830	0.7
113	Webster clay loam	50,000	13.0
114	Glencoe clay loam	15,600	4.0
128B	Grogan silt loam, 1 to 6 percent slopes	230	0.1
130	Nicollet clay loam	41,790	10.8
134	Okoboji silty clay loam	21,400	5.5
136	Madelia silty clay loam	370	0.1
140	Spicer silty clay loam	540	0.1
227	Lemond loam	6,630	1.7
247	Linder sandy loam	3,350	0.9
269	Millington clay loam	3,000	0.8
281	Darfur loam	650	0.2
282	Hanska sandy loam	4,360	1.1
313	Spillville loam	1,290	0.3
317	Oshawa silty clay loam	920	0.2
327A	Dickman sandy loam, 0 to 2 percent slopes	4,020	1.0
327B	Dickman sandy loam, 2 to 6 percent slopes	2,970	0.8
336	Delft clay loam	1,900	0.5
386	Okoboji muck	4,060	1.0
421B	Ves loam, 1 to 4 percent slopes	14,150	3.6
421B2	Ves loam, 3 to 6 percent slopes, eroded	7,170	1.8
423	Seaforth loam	14,530	3.7
446	Normania loam	25,130	6.4
463	Minneiska sandy loam	3,080	0.8
487	Hoopeston sandy loam	920	0.2
495	Zumbro loamy sand	300	0.1
499	Hanska loam, depressional	3,010	0.8
518	Kalmarville sandy loam	720	0.2
539	Palms muck	730	0.2
574	Du Page loam	530	0.1
575	Nishna silty clay	1,260	0.3
603	Hanlon sandy loam	2,020	0.5
611B	Hawick coarse sandy loam, 2 to 6 percent slopes	230	0.1
611C	Hawick coarse sandy loam, 6 to 15 percent slopes	450	0.1
639	Ridgeport sandy loam	570	0.1
820B	Dickman-Clarion complex, 2 to 6 percent slopes	1,600	0.4
919	Lemond-Canisteo complex	5,400	1.4
920B	Clarion-Estherville-Storden complex, 2 to 6 percent slopes	1,640	0.4
920C	Clarion-Estherville-Storden complex, 6 to 12 percent slopes	940	0.2
921B2	Clarion-Storden loams, 3 to 6 percent slopes, eroded	2,430	0.6
921C2	Clarion-Storden loams, 6 to 12 percent slopes, eroded	2,540	0.7
923E	Copaston-Rock outcrop complex, 0 to 40 percent slopes	170	*
929	Fieldon-Canisteo complex	2,650	0.7
946	Dickman-Nicollet complex	3,060	0.8
954B2	Ves-Storden loams, 2 to 6 percent slopes, eroded	4,830	1.2
954C2	Ves-Storden loams, 6 to 12 percent slopes, eroded	2,790	0.7
954D2	Storden-Ves loams, 12 to 18 percent slopes, eroded	1,400	0.4
960D2	Storden-Clarion loams, 12 to 18 percent slopes, eroded	580	0.1
968	Hanska-Webster complex	4,110	1.1

See footnote at end of table.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
999B	Ves-Storden-Estherville complex, 2 to 6 percent slopes	970	0.2
999C	Ves-Storden-Estherville complex, 6 to 12 percent slopes	940	0.2
999D	Storden-Ves-Hawick complex, 12 to 18 percent slopes	550	0.1
999F	Storden-Hawick complex, 18 to 50 percent slopes	530	0.1
1016	Udorthents, loamy	260	0.1
1027	Udorthents, wet substratum	350	0.1
1029	Pits, gravel	780	0.2
1052	Okoboji and Palms soils, ponded	1,990	0.5
1829B	Ridgeport Variant loam, 0 to 6 percent slopes	850	0.2
1829C	Ridgeport Variant loam, 6 to 15 percent slopes	250	0.1
1833	Coland loam	2,200	0.6
1887	Millington clay loam, sandy substratum	1,360	0.3
1909	Lemond loam, depressional	580	0.1
1911F	Storden-Ridgeport Variant loams, 15 to 50 percent slopes	650	0.2
1912	Tilfer Variant clay loam	660	0.2
1917	Nishna silty clay, ponded	1,400	0.4
1919F	Clarion-Terril loams, 25 to 50 percent slopes	3,270	0.8
1928	Hanska loam, gravelly substratum	1,610	0.4
1929	Lemond loam, gravelly substratum	2,240	0.6
1930	Dickman sandy loam, moderately wet	5,610	1.4
1931	Essexville sandy loam	580	0.1
	Water	5,500	1.4
	Total	390,400	100.0

* Less than 0.1 percent.

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
27A	Dickinson sandy loam, 0 to 2 percent slopes
27B	Dickinson sandy loam, 2 to 6 percent slopes
85	Calco silty clay loam (where drained)
86	Canisteo clay loam (where drained)
94B	Terril loam, 2 to 6 percent slopes
102B	Clarion loam, 1 to 4 percent slopes
102B2	Clarion loam, 3 to 6 percent slopes, eroded
113	Webster clay loam (where drained)
114	Glencoe clay loam (where drained)
128B	Grogan silt loam, 1 to 6 percent slopes
130	Nicollet clay loam
134	Okoboji silty clay loam (where drained)
136	Madelia silty clay loam (where drained)
140	Spicer silty clay loam (where drained)
227	Lemond loam (where drained)
247	Linder sandy loam
269	Millington clay loam (where drained)
281	Darfur loam (where drained)
282	Hanska sandy loam (where drained)
313	Spillville loam
336	Delft clay loam (where drained)
421B	Ves loam, 1 to 4 percent slopes
421B2	Ves loam, 3 to 6 percent slopes, eroded
423	Seaforth loam
446	Normania loam
463	Minneiska sandy loam
487	Hoopeston sandy loam
518	Kalmarville sandy loam (where drained)
574	Du Page loam
603	Hanlon sandy loam
639	Ridgeport sandy loam
919	Lemond-Canisteo complex (where drained)
921B2	Clarion-Storden loams, 3 to 6 percent slopes, eroded
929	Fieldon-Canisteo complex (where drained)
946	Dickman-Nicollet complex
954B2	Ves-Storden loams, 2 to 6 percent slopes, eroded
968	Hanska-Webster complex (where drained)
1833	Coland loam (where drained)
1887	Millington clay loam, sandy substratum (where drained)
1912	Tilfer Variant clay loam (where drained)
1928	Hanska loam, gravelly substratum (where drained)
1929	Lemond loam, gravelly substratum (where drained)

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Alfalfa hay
		Bu	Bu	Bu	Tons
8B---------- Sparta	IVs	50	19	40	2.0
8C---------- Sparta	VIs	---	---	---	---
27A---------- Dickinson	IIs	85	34	60	3.0
27B---------- Dickinson	IIe	80	30	55	2.9
31E---------- Storden	VIe	---	---	---	2.5
31F---------- Storden	VIIe	---	---	---	---
35---------- Blue Earth	IIIw	100	35	55	4.0
41A---------- Estherville	IIIs	60	20	40	2.0
41B---------- Estherville	IIIs	55	19	35	2.0
85---------- Calco	IIw	125	38	80	4.2
86---------- Canisteo	IIw	138	40	89	4.5
94B---------- Terril	IIe	138	42	80	4.0
94C---------- Terril	IIIe	120	38	75	3.4
102B---------- Clarion	IIe	135	42	80	4.0
102B2---------- Clarion	IIe	132	41	78	3.9
113---------- Webster	IIw	140	46	90	4.4
114---------- Glencoe	IIIw	130	43	85	3.5
128B---------- Grogan	IIe	137	45	85	4.5
130---------- Nicollet	I	137	45	85	4.5
134---------- Okoboji	IIIw	138	43	85	3.5

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Alfalfa hay
		Bu	Bu	Bu	Tons
136--Madelia	IIw	138	42	87	4.5
140--Spicer	IIw	136	36	86	4.5
227--Lemond	IIw	118	30	70	3.5
247--Linder	IIs	65	23	45	2.5
269--Millington	IIw	125	38	80	4.2
281--Darfur	IIw	125	40	75	4.0
282--Hanska	IIw	120	35	70	3.5
313--Spillville	IIw	120	40	80	4.2
317--Oshawa	VIw	---	---	---	---
327A--Dickman	IIIs	65	22	4.5	2.2
327B--Dickman	IIIe	60	20	45	2.1
336--Delft	IIw	136	42	87	4.5
386--Okoboji	IIIw	128	38	75	3.3
421B--Ves	IIe	133	41	80	4.0
421B2--Ves	IIe	130	40	77	4.0
423--Seaforth	IIs	130	40	82	4.6
446--Normania	I	135	44	85	4.5
463--Minneiska	IIw	90	30	50	2.4
487--Hoopeston	IIs	100	35	65	3.5
495--Zumbro	IIIs	70	25	45	2.3
499--Hanska	IIIw	115	35	70	3.0

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Alfalfa hay
		Bu	Bu	Bu	Tons
518---------- Kalmarville	IIw	90	30	60	4.0
539---------- Palms	IIIw	120	35	70	3.3
574---------- Du Page	IIw	120	40	80	4.2
575---------- Nishna	IIIw	125	40	80	4.2
603---------- Hanlon	IIs	110	40	70	3.5
611B---------- Hawick	IVs	45	17	35	1.8
611C---------- Hawick	IVs	30	15	25	1.6
639---------- Ridgeport	IIIs	70	25	55	2.6
820B---------- Dickman-Clarion	IIIe	75	28	55	3.0
919---------- Lemond-Canisteo	IIw	120	31	74	4.0
920B---------- Clarion-Estherville-Storden	IIIe	110	28	60	3.2
920C---------- Clarion-Estherville-Storden	IVe	95	24	52	2.7
921B2---------- Clarion-Storden	IIe	130	38	78	3.7
921C2---------- Clarion-Storden	IIIe	115	34	68	3.2
923E*---------- Copaston-Rock outcrop	VIIs	---	---	---	---
929---------- Fieldon-Canisteo	IIw	125	35	75	4.0
946---------- Dickman-Nicollet	IIIs	85	32	60	3.5
954B2---------- Ves-Storden	IIe	128	37	77	3.7
954C2---------- Ves-Storden	IIIe	113	33	67	3.2
954D2---------- Storden-Ves	IVe	88	25	54	2.8

See footnote at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Alfalfa hay
		Bu	Bu	Bu	Tons
960D2--- Storden-Clarion	IVe	90	26	55	2.8
968--- Hanska-Webster	IIw	125	37	76	4.0
999B--- Ves-Storden-Estherville	IIIe	108	27	60	3.2
999C--- Ves-Storden-Estherville	IVe	93	23	51	2.7
999D--- Storden-Ves-Hawick	IVe	65	15	40	2.2
999F--- Storden-Hawick	VIIe	---	---	---	---
1016, 1027. Udorthents					
1029*--- Pits	VIIIs	---	---	---	---
1052--- Okoboji and Palms	VIIIw	---	---	---	---
1829B--- Ridgeport Variant	IIe	75	28	60	2.5
1829C--- Ridgeport Variant	IVe	60	21	50	2.0
1833--- Coland	IIw	125	40	80	4.2
1887--- Millington	IIw	105	38	80	4.2
1909--- Lemond	IIIw	110	35	70	3.0
1911F--- Storden-Ridgeport Variant	VIIe	---	---	---	---
1912--- Tilfer Variant	IIw	115	35	65	4.0
1917--- Nishna	VIw	---	---	---	---
1919F--- Clarion-Terril	VIIe	---	---	---	---
1928--- Hanska	IIw	120	35	70	3.5
1929--- Lemond	IIw	118	30	70	3.5

See footnote at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Oats	Alfalfa hay
		Bu	Bu	Bu	Tons
1930---------- Dickman	IIIs	70	25	50	2.7
1931---------- Essexville	IIIw	100	32	75	4.2

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
8B, 8C---------- Sparta	Siberian peashrub	Eastern redcedar, lilac, Tatarian honeysuckle.	Austrian pine, jack pine, red pine, honeylocust, green ash, Russian-olive, Siberian elm.	Eastern white pine	---
27A, 27B---------- Dickinson	Lilac----------	Eastern redcedar, Russian-olive, Tatarian honeysuckle, Siberian peashrub.	Eastern white pine, green ash, Norway spruce, honeylocust, red pine, Amur maple, hackberry.	---	---
31E, 31F---------- Storden	American plum-----	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---
35---------- Blue Earth	---	Redosier dogwood	Black ash, tall purple willow.	Black ash, golden willow, white willow.	---
41A, 41B---------- Estherville	Siberian peashrub	Eastern redcedar, lilac, Tatarian honeysuckle.	Honeylocust, jack pine, green ash, Russian-olive, red pine, Austrian pine, Siberian elm.	Eastern white pine	---
85---------- Calco	---	Lilac, Tatarian honeysuckle, Siberian peashrub, northern white-cedar.	Hackberry, eastern redcedar, bur oak, white spruce.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
86---------- Canisteo	---	Siberian peashrub, Tatarian honeysuckle, lilac, northern white-cedar.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
94B, 94C---------- Terril	---	Gray dogwood, Siberian peashrub, redosier dogwood, lilac.	Honeylocust, Russian-olive, Amur maple, blue spruce, northern white-cedar, eastern redcedar.	Eastern white pine, green ash.	---

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
102B, 102B2---- Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
113---- Webster	---	Redosier dogwood, American plum, Tatarian honeysuckle.	Hackberry, Amur maple, northern white-cedar, tall purple willow, white spruce.	Golden willow, green ash.	Eastern cottonwood, silver maple.
114---- Glencoe	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, golden willow, white willow.	---
128B---- Grogan	---	Redosier dogwood, gray dogwood, Siberian peashrub, lilac.	Northern white-cedar, blue spruce, Russian-olive, hackberry, Amur maple, eastern redcedar.	Eastern white pine, green ash.	---
130---- Nicollet	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Austrian pine, eastern white pine, green ash, hackberry.	Silver maple.
134---- Okoboji	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, white willow, golden willow.	---
136---- Madelia	---	American plum, Tatarian honeysuckle, redosier dogwood.	Northern white-cedar, white spruce, hackberry, Amur maple, tall purple willow.	Golden willow, green ash.	Silver maple, eastern cottonwood.
140---- Spicer	---	Tatarian honeysuckle, lilac, Siberian peashrub, northern white-cedar.	Bur oak, hackberry, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
227---- Lemond	---	Northern white-cedar, Tatarian honeysuckle, Siberian peashrub, lilac.	Bur oak, hackberry, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
247---- Linder	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Blue spruce, Amur maple, white spruce, northern white-cedar.	Eastern white pine, Austrian pine, green ash, hackberry.	Silver maple.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
269---------- Millington	---	Tatarian honeysuckle, northern white-cedar, lilac, Siberian peashrub.	Hackberry, white spruce, eastern redcedar, bur oak.	Honeylocust, green ash, golden willow.	Eastern cottonwood.
281---------- Darfur	---	Redosier dogwood, Tatarian honeysuckle, American plum.	Northern white-cedar, white spruce, tall purple willow, Amur maple, hackberry.	Golden willow, green ash.	Eastern cottonwood, silver maple.
282---------- Hanska	---	Tatarian honeysuckle, American plum, redosier dogwood.	Northern white-cedar, white spruce, tall purple willow, Amur maple, hackberry.	Golden willow, green ash.	Eastern cottonwood, silver maple.
313---------- Spillville	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
317. Oshawa					
327A, 327B-------- Dickman	Siberian peashrub	Eastern redcedar, Tatarian honeysuckle, lilac.	Green ash, honeylocust, red pine, jack pine, Austrian pine, Russian-olive.	Eastern white pine, Siberian elm.	---
336---------- Delft	---	Tatarian honeysuckle, redosier dogwood, American plum.	Hackberry, Amur maple, white spruce, northern white-cedar, tall purple willow.	Green ash, golden willow.	Silver maple, eastern cottonwood.
386---------- Okoboji	---	Redosier dogwood	Black ash, tall purple willow.	Black willow, white willow, golden willow.	---
421B, 421B2------- Ves	---	Siberian peashrub, redosier dogwood, gray dogwood, lilac.	Eastern redcedar, northern white-cedar, Amur maple, blue spruce, hackberry, Russian-olive.	Green ash, eastern white pine.	---
423---------- Seaforth	---	Siberian peashrub, lilac, northern white-cedar, Tatarian honeysuckle.	Eastern redcedar, white spruce, bur oak, hackberry.	Green ash, honeylocust, golden willow.	Eastern cottonwood.
446---------- Normania	---	Lilac, redosier dogwood, Tatarian honeysuckle.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Eastern white pine, Austrian pine, hackberry, green ash.	Silver maple.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
463---------- Minneiska	---	Northern white-cedar, Tatarian honeysuckle, lilac, Siberian peashrub.	Hackberry, white spruce, eastern redcedar, bur oak.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
487---------- Hoopeston	---	Northern white-cedar, nannyberry viburnum, redosier dogwood, lilac.	Amur maple, white spruce.	Eastern white pine, hackberry, red maple, white ash, green ash.	Silver maple.
495---------- Zumbro	---	Lilac, Tatarian honeysuckle, redosier dogwood.	Blue spruce, northern white-cedar, white spruce, Amur maple.	Austrian pine, hackberry, eastern white pine, green ash.	Silver maple.
499---------- Hanska	---	American plum, Tatarian honeysuckle, redosier dogwood.	Northern white-cedar, white spruce, hackberry, Amur maple, tall purple willow.	Golden willow, green ash.	Silver maple, eastern cottonwood.
518---------- Kalmarville	---	Tatarian honeysuckle, Siberian peashrub, lilac, northern white-cedar.	Eastern redcedar, hackberry, white spruce, bur oak.	Golden willow, green ash, honeylocust.	Eastern cottonwood.
539---------- Palms	Common ninebark---	Whitebelle honeysuckle, Amur privet, silky dogwood, nannyberry viburnum, Tatarian honeysuckle.	Tall purple willow	Golden willow, black willow.	Imperial Carolina poplar.
574---------- Du Page	---	Northern white-cedar, Siberian peashrub, lilac, Tatarian honeysuckle.	Hackberry, bur oak, eastern redcedar, white spruce.	Green ash, golden willow, honeylocust.	Eastern cottonwood.
575---------- Nishna	Lilac----------	Tatarian honeysuckle, Siberian peashrub.	Russian-olive, eastern redcedar, blue spruce, ponderosa pine, hackberry.	Honeylocust, green ash, golden willow.	Eastern cottonwood.
603---------- Hanlon	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Amur maple, blue spruce, white spruce, northern white-cedar.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
611B, 611C-------- Hawick	Siberian peashrub	Lilac, Tatarian honeysuckle, eastern redcedar.	Jack pine, Austrian pine, red pine, green ash, honeylocust, Russian-olive, Siberian elm.	Eastern white pine	---

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
639---------- Ridgeport	Tatarian honeysuckle, lilac, Siberian peashrub.	Eastern redcedar, hackberry, Manchurian crabapple.	Eastern white pine, jack pine, honeylocust, Russian-olive, bur oak, green ash.	---	---
820B*:					
Dickman----------	Siberian peashrub	Eastern redcedar, Tatarian honeysuckle, lilac.	Green ash, honeylocust, red pine, jack pine, Austrian pine, Russian-olive.	Eastern white pine, Siberian elm.	---
Clarion----------	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
919*:					
Lemond----------	---	Northern white-cedar, Tatarian honeysuckle, Siberian peashrub, lilac.	Bur oak, hackberry, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
Canisteo---------	---	Siberian peashrub, Tatarian honeysuckle, lilac, northern white-cedar.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
920B*, 920C*:					
Clarion----------	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
Estherville------	Siberian peashrub	Eastern redcedar, lilac, Tatarian honeysuckle.	Honeylocust, jack pine, green ash, Russian-olive, red pine, Austrian pine, Siberian elm.	Eastern white pine	---
Storden----------	American plum-----	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
921B2*, 921C2*:					
Clarion	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
Storden	American plum	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
923E*:					
Copaston.					
Rock outcrop.					
929*:					
Fieldon	---	Northern white-cedar, lilac, Tatarian honeysuckle, Siberian peashrub.	White spruce, eastern redcedar, bur oak, hackberry.	Honeylocust, green ash, golden willow.	Eastern cottonwood.
Canisteo	---	Siberian peashrub, Tatarian honeysuckle, lilac, northern white-cedar.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
946*:					
Dickman	Siberian peashrub	Tatarian honeysuckle, lilac, eastern redcedar.	Austrian pine, green ash, honeylocust, jack pine, red pine, Russian-olive.	Siberian elm, eastern white pine.	---
Nicollet	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Austrian pine, eastern white pine, green ash, hackberry.	Silver maple.
954B2*, 954C2*:					
Ves	---	Siberian peashrub, redosier dogwood, gray dogwood, lilac.	Eastern redcedar, northern white-cedar, Amur maple, blue spruce, hackberry, Russian-olive.	Green ash, eastern white pine.	---
Storden	American plum	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
954D2*:					
Storden----------	American plum-----	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---
Ves----------	---	Siberian peashrub, redosier dogwood, gray dogwood, lilac.	Eastern redcedar, northern white-cedar, Amur maple, blue spruce, hackberry, Russian-olive.	Green ash, eastern white pine.	---
960D2*:					
Storden----------	American plum-----	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---
Clarion----------	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
968*:					
Hanska----------	---	Tatarian honeysuckle, American plum, redosier dogwood.	Northern white-cedar, white spruce, tall purple willow, Amur maple, hackberry.	Golden willow, green ash.	Eastern cottonwood, silver maple.
Webster----------	---	Redosier dogwood, American plum, Tatarian honeysuckle.	Hackberry, Amur maple, northern white-cedar, tall purple willow, white spruce.	Golden willow, green ash.	Eastern cottonwood, silver maple.
999B*, 999C*:					
Ves----------	---	Siberian peashrub, redosier dogwood, gray dogwood, lilac.	Eastern redcedar, northern white-cedar, Amur maple, blue spruce, hackberry, Russian-olive.	Green ash, eastern white pine.	---
Storden----------	American plum-----	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
999B*, 999C*: Estherville	Siberian peashrub	Eastern redcedar, lilac, Tatarian honeysuckle.	Honeylocust, jack pine, green ash, Russian-olive, red pine, Austrian pine, Siberian elm.	Eastern white pine	---
999D*: Storden	American plum	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
Ves	---	Siberian peashrub, redosier dogwood, gray dogwood, lilac.	Eastern redcedar, northern white-cedar, Amur maple, blue spruce, hackberry, Russian-olive.	Green ash, eastern white pine.	---
Hawick	Siberian peashrub	Lilac, Tatarian honeysuckle, eastern redcedar.	Jack pine, Austrian pine, red pine, green ash, honeylocust, Russian-olive, Siberian elm.	Eastern white pine	---
999F*: Storden	American plum	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
Hawick	Siberian peashrub	Lilac, Tatarian honeysuckle, eastern redcedar.	Jack pine, Austrian pine, red pine, green ash, honeylocust, Russian-olive, Siberian elm.	Eastern white pine	---
1016, 1027. Udorthents					
1029*. Pits					
1052*: Okoboji.					
Palms.					
1829B, 1829C Ridgeport Variant	American plum	Eastern redcedar, Siberian peashrub, hackberry, Tatarian honeysuckle.	Green ash, honeylocust, Russian-olive.	Siberian elm	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1833---------- Coland	---	Redosier dogwood, Tatarian honeysuckle, American plum.	White spruce, hackberry, northern white-cedar, tall purple willow, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.
1887---------- Millington	---	Tatarian honeysuckle, northern white-cedar, Siberian peashrub, lilac.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, green ash, honeylocust.	Eastern cottonwood.
1909---------- Lemond	---	American plum, Tatarian honeysuckle, redosier dogwood.	Northern white-cedar, white spruce, hackberry, Amur maple, tall purple willow.	Golden willow, green ash.	Silver maple, eastern cottonwood.
1911F*:					
Storden----------	American plum-----	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---
Ridgeport Variant	American plum-----	Eastern redcedar, Siberian peashrub, hackberry, Tatarian honeysuckle.	Green ash, honeylocust, Russian-olive.	Siberian elm------	---
1912---------- Tilfer Variant	---	Tatarian honeysuckle, lilac, Siberian peashrub, northern white-cedar.	Eastern redcedar, white spruce, hackberry, bur oak.	Golden willow, green ash, honeylocust.	Eastern cottonwood.
1917---------- Nishna	Lilac----------	Tatarian honeysuckle, Siberian peashrub.	Russian-olive, blue spruce, eastern redcedar, ponderosa pine, hackberry.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
1919F*:					
Clarion----------	---	Gray dogwood, redosier dogwood, lilac, Siberian peashrub.	Northern white-cedar, blue spruce, Amur maple, Russian-olive, eastern redcedar, hackberry.	Green ash, eastern white pine.	---
Terril----------	---	Gray dogwood, Siberian peashrub, redosier dogwood, lilac.	Honeylocust, Russian-olive, Amur maple, blue spruce, northern white-cedar, eastern redcedar.	Eastern white pine, green ash.	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1928---------- Hanska	---	Tatarian honeysuckle, American plum, redosier dogwood.	Northern white-cedar, white spruce, tall purple willow, Amur maple, hackberry.	Golden willow, green ash.	Eastern cottonwood, silver maple.
1929---------- Lemond	---	Northern white-cedar, Tatarian honeysuckle, Siberian peashrub, lilac.	Bur oak, hackberry, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
1930---------- Dickman	Siberian peashrub	Tatarian honeysuckle, lilac, eastern redcedar.	Austrian pine, green ash, honeylocust, jack pine, red pine, Russian-olive.	Siberian elm, eastern white pine.	---
1931---------- Essexville	---	Siberian peashrub, Tatarian honeysuckle, lilac, northern white-cedar.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
8B Sparta	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
8C Sparta	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
27A Dickinson	Slight	Slight	Slight	Slight	Slight.
27B Dickinson	Slight	Slight	Moderate: slope.	Slight	Slight.
31E Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
31F Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
35 Blue Earth	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding.
41A Estherville	Slight	Slight	Moderate: small stones.	Slight	Moderate: droughty.
41B Estherville	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
85 Calco	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
86 Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
94B Terril	Slight	Slight	Moderate: slope.	Slight	Slight.
94C Terril	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
102B, 102B2 Clarion	Slight	Slight	Moderate: slope.	Slight	Slight.
113 Webster	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
114 Glencoe	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
128B Grogan	Slight	Slight	Moderate: slope.	Slight	Slight.
130 Nicollet	Slight	Slight	Slight	Slight	Slight.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
134--Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
136--Madelia	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
140--Spicer	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
227--Lemond	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
247--Linder	Slight	Slight	Slight	Slight	Slight.
269--Millington	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
281--Darfur	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
282--Hanska	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
313--Spillville	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
317--Oshawa	Severe: flooding, ponding.	Severe: ponding.	Severe: ponding, flooding.	Severe: ponding.	Severe: ponding, flooding.
327A--Dickman	Slight	Slight	Slight	Slight	Moderate: droughty.
327B--Dickman	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
336--Delft	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
386--Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
421B, 421B2--Ves	Slight	Slight	Moderate: slope.	Slight	Slight.
423--Seaforth	Slight	Slight	Moderate: slope.	Slight	Slight.
446--Normania	Slight	Slight	Slight	Slight	Slight.
463--Minneiska	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
487--Hoopeston	Slight	Slight	Slight	Slight	Slight.
495--Zumbro	Severe: flooding.	Slight	Slight	Slight	Slight.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
499--- Hanska	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
518--- Kalmarville	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
539--- Palms	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
574--- Du Page	Severe: flooding.	Slight---	Moderate: flooding.	Slight---	Moderate: flooding.
575--- Nishna	Severe: flooding, wetness, too clayey.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey.	Severe: too clayey.
603--- Hanlon	Severe: flooding.	Slight---	Moderate: flooding.	Slight---	Moderate: flooding.
611B--- Hawick	Slight---	Slight---	Moderate: slope.	Slight---	Moderate: droughty.
611C--- Hawick	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight---	Moderate: droughty, slope.
639--- Ridgeport	Slight---	Slight---	Slight---	Slight---	Slight.
820B*:					
Dickman---	Slight---	Slight---	Moderate: slope.	Slight---	Moderate: droughty.
Clarion---	Slight---	Slight---	Moderate: slope.	Slight---	Slight.
919*:					
Lemond---	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Canisteo---	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
920B*:					
Clarion---	Slight---	Slight---	Moderate: slope.	Slight---	Slight.
Estherville---	Slight---	Slight---	Moderate: slope, small stones.	Slight---	Moderate: droughty.
Storden---	Slight---	Slight---	Moderate: slope.	Slight---	Slight.
920C*:					
Clarion---	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight---	Moderate: slope.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
920C*:					
Estherville	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
921B2*:					
Clarion	Slight	Slight	Moderate: slope.	Slight	Slight.
Storden	Slight	Slight	Moderate: slope.	Slight	Slight.
921C2*:					
Clarion	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
923E*:					
Copaston	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight	Severe: depth to rock.
Rock outcrop.					
929*:					
Fieldon	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
946*:					
Dickman	Slight	Slight	Slight	Slight	Moderate: droughty.
Nicollet	Slight	Slight	Slight	Slight	Slight.
954B2*:					
Ves	Slight	Slight	Moderate: slope.	Slight	Slight.
Storden	Slight	Slight	Moderate: slope.	Slight	Slight.
954C2*:					
Ves	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
954D2*:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
954D2*:					
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
960D2*:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Clarion	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
968*:					
Hanska	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Webster	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
999B*:					
Ves	Slight	Slight	Moderate: slope.	Slight	Slight.
Storden	Slight	Slight	Moderate: slope.	Slight	Slight.
Estherville	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
999C*:					
Ves	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Estherville	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
999D*:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Hawick	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
999F*:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Hawick	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1016, 1027. Udorthents					

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1029*. Pits					
1052*: Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
Palms	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.	Severe: ponding, excess humus.
1829B--- Ridgeport Variant	Slight---	Slight---	Moderate: slope, small stones, depth to rock.	Slight---	Moderate: droughty, depth to rock.
1829C--- Ridgeport Variant	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight---	Moderate: droughty, slope, depth to rock.
1833--- Coland	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
1887--- Millington	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
1909--- Lemond	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
1911F*: Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Ridgeport Variant	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1912--- Tilfer Variant	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, depth to rock.
1917--- Nishna	Severe: flooding, ponding, too clayey.	Severe: ponding, too clayey.	Severe: too clayey, ponding, flooding.	Severe: ponding.	Severe: ponding, flooding, too clayey.
1919F*: Clarion	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Terril	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1928--- Hanska	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
1929--- Lemond	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1930---------- Dickman	Slight----------	Slight----------	Slight----------	Slight----------	Moderate: droughty.
1931---------- Essexville	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
8B---------- Sparta	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
8C---------- Sparta	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
27A, 27B---------- Dickinson	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
31E, 31F---------- Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
35---------- Blue Earth	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Poor	Good.
41A, 41B---------- Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
85---------- Calco	Good	Fair	Good	Poor	Very poor.	Good	Good	Fair	Poor	Fair.
86---------- Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
94B---------- Terril	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
94C---------- Terril	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
102B, 102B2-------- Clarion	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
113---------- Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
114---------- Glencoe	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
128B---------- Grogan	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
130---------- Nicollet	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
134---------- Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
136---------- Madelia	Good	Good	Good	Good	Fair	Good	Good	Good	Fair	Good.
140---------- Spicer	Good	Good	Fair	Fair	Poor	Good	Good	Good	Fair	Good.
227---------- Lemond	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
247---------- Linder	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
269---------- Millington	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Poor.
281---------- Darfur	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
282---------- Hanska	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
313---------- Spillville	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
317---------- Oshawa	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
327A, 327B--------- Dickman	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
336---------- Delft	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
386---------- Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
421B, 421B2-------- Ves	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
423---------- Seaforth	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
446---------- Normania	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
463---------- Minneiska	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
487---------- Hoopeston	Fair	Good	Good	Good	Good	Fair	Poor	Good	Good	Poor.
495---------- Zumbro	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Poor.
499---------- Hanska	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
518---------- Kalmarville	Good	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
539---------- Palms	Good	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
574---------- Du Page	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
575---------- Nishna	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
603---------- Hanlon	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
611B, 611C---------- Hawick	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
639---------- Ridgeport	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
820B*:										
Dickman----------	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Clarion----------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
919*:										
Lemond----------	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
Canisteo----------	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
920B*:										
Clarion----------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Estherville-------	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Storden----------	Good	Good	Good	Fair	Poor	Very poor.	Very poor.	Good	Fair	Very poor.
920C*:										
Clarion----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Estherville-------	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Storden----------	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
921B2*:										
Clarion----------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Storden----------	Good	Good	Good	Fair	Poor	Very poor.	Very poor.	Good	Fair	Very poor.
921C2*:										
Clarion----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Storden----------	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
923E*:										
Copaston----------	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
Rock outcrop.										
929*:										
Fieldon----------	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
929*:										
Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
946*:										
Dickman	Fair	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Poor.
Nicollet	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
954B2*:										
Ves	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Storden	Good	Good	Good	Fair	Poor	Very poor.	Very poor.	Good	Fair	Very poor.
954C2*:										
Ves	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
954D2*:										
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Ves	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
960D2*:										
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Clarion	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
968*:										
Hanska	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
999B*:										
Ves	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Storden	Good	Good	Good	Fair	Poor	Very poor.	Very poor.	Good	Fair	Very poor.
Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
999C*:										
Ves	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
999D*:										
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Ves	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Hawick	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
999F*:										
Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Hawick	Very poor.	Very poor.	Fair	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
1016, 1027. Udorthents										
1029*. Pits										
1052*:										
Okoboji	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Good	Good	Very poor.	Very poor.	Good.
Palms	Good	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
1829B, 1829C--- Ridgeport Variant	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
1833 Coland	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
1887 Millington	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
1909 Lemond	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
1911F*:										
Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Ridgeport Variant	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
1912 Tilfer Variant	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
1917 Nishna	Very poor.	Poor	Fair	Poor	Very poor.	Good	Good	Poor	Poor	Good.
1919F*:										
Clarion	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Terril	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
1928---------- Hanska	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
1929---------- Lemond	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
1930---------- Dickman	Fair	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Poor.
1931---------- Essexville	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Fair	Poor	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
8B---------- Sparta	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
8C---------- Sparta	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
27A---------- Dickinson	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Slight.
27B---------- Dickinson	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
31E, 31F---------- Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
35---------- Blue Earth	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: low strength, ponding, frost action.	Severe: ponding.
41A---------- Estherville	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
41B---------- Estherville	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
85---------- Calco	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
86---------- Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
94B---------- Terril	Slight---------	Slight---------	Slight---------	Moderate: slope.	Severe: low strength.	Slight.
94C---------- Terril	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength.	Moderate: slope.
102B---------- Clarion	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: frost action.	Slight.
102B2---------- Clarion	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: frost action.	Slight.
113---------- Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
114---------- Glencoe	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding, low strength, frost action.	Severe: ponding.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
128B---------- Grogan	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Severe: frost action.	Slight.
130---------- Nicollet	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
134---------- Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
136---------- Madelia	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
140---------- Spicer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action, low strength.	Moderate: wetness.
227---------- Lemond	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
247---------- Linder	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Slight---------	Severe: frost action.	Slight.
269---------- Millington	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.	Severe: wetness.
281---------- Darfur	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
282---------- Hanska	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
313---------- Spillville	Moderate: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Moderate: flooding.
317---------- Oshawa	Severe: ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: low strength, ponding, flooding.	Severe: ponding, flooding.
327A---------- Dickman	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
327B---------- Dickman	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
336---------- Delft	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
386---------- Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding, excess humus.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
421B---------- Ves	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: low strength, frost action.	Slight.
421B2---------- Ves	Slight---------	Slight---------	Slight---------	Moderate: slope.	Moderate: low strength, frost action.	Slight.
423---------- Seaforth	Moderate: wetness.	Slight---------	Moderate: wetness.	Slight---------	Severe: frost action.	Slight.
446---------- Normania	Moderate: wetness.	Slight---------	Moderate: wetness.	Slight---------	Severe: frost action.	Slight.
463---------- Minneiska	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.
487---------- Hoopeston	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Slight---------	Severe: frost action.	Slight.
495---------- Zumbro	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.	Slight.
499---------- Hanska	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
518---------- Kalmarville	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding, frost action.	Severe: wetness.
539---------- Palms	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action, subsides.	Severe: ponding, excess humus.
574---------- Du Page	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Moderate: flooding.
575---------- Nishna	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, wetness, flooding.	Severe: flooding, low strength, shrink-swell.	Severe: too clayey.
603---------- Hanlon	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.
611B---------- Hawick	Severe: cutbanks cave.	Slight---------	Slight---------	Moderate: slope.	Slight---------	Moderate: droughty.
611C---------- Hawick	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
639---------- Ridgeport	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
820B*:						
Dickman	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
Clarion	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
919*:						
Lemond	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
920B*:						
Clarion	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
Estherville	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
Storden	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
920C*:						
Clarion	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Estherville	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
921B2*:						
Clarion	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
Storden	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
921C2*:						
Clarion	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
923E*:						
Copaston	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.	Severe: depth to rock.
Rock outcrop.						

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
929*:						
Fieldon	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
946*:						
Dickman	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Slight	Moderate: droughty.
Nicollet	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
954B2*:						
Ves	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.
Storden	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
954C2*:						
Ves	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
954D2*:						
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
960D2*:						
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Clarion	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
968*:						
Hanska	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
999B*:						
Ves	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.
Storden	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
Estherville	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
999C*:						
Ves	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Estherville	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
999D*:						
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Hawick	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
999F*:						
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Hawick	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1016, 1027. Udorthents						
1029*. Pits						
1052*:						
Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
Palms	Severe: excess humus, ponding.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, low strength.	Severe: ponding, frost action, subsides.	Severe: ponding, excess humus.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1829B---------- Ridgeport Variant	Severe: cutbanks cave.	Slight---------	Moderate: depth to rock.	Slight---------	Slight---------	Moderate: droughty, depth to rock.
1829C---------- Ridgeport Variant	Severe: cutbanks cave.	Moderate: slope.	Moderate: depth to rock, slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope, depth to rock.
1833---------- Coland	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
1887---------- Millington	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
1909---------- Lemond	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding, frost action.	Severe: ponding.
1911F*:						
Storden----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Ridgeport Variant	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1912---------- Tilfer Variant	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness, depth to rock.
1917---------- Nishna	Severe: ponding.	Severe: flooding, ponding, shrink-swell.	Severe: flooding, ponding, shrink-swell.	Severe: flooding, ponding, shrink-swell.	Severe: low strength, ponding, flooding.	Severe: ponding, flooding, too clayey.
1919F*:						
Clarion----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Terril----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
1928---------- Hanska	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
1929---------- Lemond	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
1930---------- Ridgeport Variant	Severe: cutbanks cave.	Slight---------	Moderate: depth to rock.	Slight---------	Slight---------	Moderate: droughty, depth to rock.
1931---------- Essexville	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
8B Sparta	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
8C Sparta	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
27A, 27B Dickinson	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
31E, 31F Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
35 Blue Earth	Severe: ponding.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: hard to pack, ponding.
41A, 41B Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
85 Calco	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
86 Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
94B Terril	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
94C Terril	Moderate: slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
102B, 102B2 Clarion	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
113 Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
114 Glencoe	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: ponding, hard to pack.
128B Grogan	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
130 Nicollet	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
134---------- Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
136---------- Madelia	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
140---------- Spicer	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
227---------- Lemond	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
247---------- Linder	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, small stones, too sandy.
269---------- Millington	Severe: flooding, wetness.	Severe: wetness, flooding.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
281---------- Darfur	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, wetness.
282---------- Hanska	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
313---------- Spillville	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, flooding.	Fair: wetness.
317---------- Oshawa	Severe: flooding, ponding, percs slowly.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Poor: ponding.
327A, 327B---------- Dickman	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
336---------- Delft	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
386---------- Okoboji	Severe: ponding, percs slowly.	Severe: ponding, excess humus.	Severe: ponding, too clayey.	Severe: ponding, excess humus.	Poor: too clayey, hard to pack, ponding.
421B, 421B2---------- Ves	Slight----------	Moderate: seepage, slope.	Slight----------	Slight----------	Good.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
423---------- Seaforth	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
446---------- Normania	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
463---------- Minneiska	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Fair: wetness.
487---------- Hoopeston	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
495---------- Zumbro	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: too sandy, thin layer.
499---------- Hanska	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
518---------- Kalmarville	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness, seepage.	Poor: wetness.
539---------- Palms	Severe: subsides, ponding.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, seepage.	Poor: ponding, excess humus.
574---------- Du Page	Severe: flooding.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Good.
575---------- Nishna	Severe: flooding, percs slowly, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
603---------- Hanlon	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Fair: wetness.
611B---------- Hawick	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
611C---------- Hawick	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
639---------- Ridgeport	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: thin layer.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
820B*:					
Dickman	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Clarion	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
919*:					
Lemond	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
920B*:					
Clarion	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Storden	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
920C*:					
Clarion	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Estherville	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
921B2*:					
Clarion	Slight	Moderate: slope, seepage.	Slight	Slight	Good.
Storden	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
921C2*:					
Clarion	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
923E*:					
Copaston	Severe: depth to rock.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: depth to rock.
Rock outcrop.					
929*:					
Fieldon	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, wetness.
Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
946*:					
Dickman	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
Nicollet	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
954B2*:					
Ves	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Storden	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
954C2*:					
Ves	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
954D2*:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
960D2*:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Clarion	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
968*:					
Hanska	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
968*: Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
999B*: Ves	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Storden	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
999C*: Ves	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Estherville	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
999D*: Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Hawick	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
999F*: Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Hawick	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
1016, 1027. Udorthents					
1029*. Pits					

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1052*:					
Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding, too clayey.	Severe: ponding.	Poor: too clayey, hard to pack, ponding.
Palms	Severe: subsides, ponding.	Severe: seepage, excess humus, ponding.	Severe: ponding, excess humus.	Severe: ponding, seepage.	Poor: ponding, excess humus.
1829B--Ridgeport Variant	Severe: depth to rock, poor filter.	Severe: seepage, depth to rock.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: depth to rock, seepage, too sandy.
1829C--Ridgeport Variant	Severe: depth to rock, poor filter.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: depth to rock, seepage, too sandy.
1833--Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
1887--Millington	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: wetness, thin layer.
1909--Lemond	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, ponding.
1911F*:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Ridgeport Variant	Severe: depth to rock, poor filter, slope.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage, slope.	Severe: depth to rock, seepage, slope.	Poor: depth to rock, seepage, too sandy.
1912--Tilfer Variant	Severe: depth to rock, wetness.	Severe: depth to rock, wetness.	Severe: depth to rock, wetness.	Severe: depth to rock, wetness.	Poor: depth to rock, wetness.
1917--Nishna	Severe: flooding, ponding, percs slowly.	Severe: flooding, ponding.	Severe: flooding, ponding, too clayey.	Severe: flooding, ponding.	Poor: too clayey, hard to pack, ponding.
1919F*:					
Clarion	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Terril	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1928---------- Hanska	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
1929---------- Lemond	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
1930---------- Dickman	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy.
1931---------- Essexville	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
8B, 8C Sparta	Good	Probable	Improbable: too sandy.	Poor: too sandy.
27A, 27B Dickinson	Good	Probable	Improbable: too sandy.	Good.
31E Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
31F Storden	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
35 Blue Earth	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
41A, 41B Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
85 Calco	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
86 Canisteo	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
94B Terril	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
94C Terril	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
102B, 102B2 Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
113 Webster	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
114 Glencoe	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
128B Grogan	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
130 Nicollet	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
134 Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
136--Madelia	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
140--Spicer	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
227--Lemond	Fair: wetness.	Probable	Improbable: too sandy.	Fair: thin layer.
247--Linder	Good	Probable	Probable	Poor: small stones, area reclaim.
269--Millington	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
281--Darfur	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
282--Hanska	Fair: wetness.	Probable	Improbable: too sandy.	Fair: thin layer.
313--Spillville	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
317--Oshawa	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
327A, 327B--Dickman	Good	Probable	Improbable: too sandy.	Poor: thin layer.
336--Delft	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
386--Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess humus.
421B, 421B2--Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
423--Seaforth	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
446--Normania	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
463--Minneiska	Good	Probable	Improbable: too sandy.	Good.
487--Hoopeston	Fair: wetness.	Probable	Improbable: too sandy.	Fair: thin layer.
495--Zumbro	Good	Probable	Improbable: too sandy.	Fair: too sandy.
499--Hanska	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
518--Kalmarville	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
539--Palms	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess humus.
574--Du Page	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
575--Nishna	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
603--Hanlon	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
611B, 611C--Hawick	Good	Probable	Probable	Poor: small stones, area reclaim.
639--Ridgeport	Good	Probable	Probable	Fair: small stones, area reclaim, thin layer.
820B*:				
Dickman	Good	Probable	Improbable: too sandy.	Poor: thin layer.
Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
919*:				
Lemond	Fair: wetness.	Probable	Improbable: too sandy.	Fair: thin layer.
Canisteo	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
920B*:				
Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
920C*:				
Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
920C*:				
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
921B2*:				
Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
921C2*:				
Clarion	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
923E*:				
Copaston	Poor: depth to rock.	Improbable: excess fines.	Improbable: excess fines.	Poor: depth to rock, small stones.
Rock outcrop.				
929*:				
Fieldon	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
Canisteo	Fair: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
946*:				
Dickman	Good	Probable	Improbable: too sandy.	Fair: small stones, thin layer.
Nicollet	Fair: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
954B2*:				
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
954C2*:				
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
954D2*:				
Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Ves	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
960D2*:				
Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Clarion	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
968*:				
Hanska	Fair: wetness.	Probable	Improbable: too sandy.	Fair: thin layer.
Webster	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
999B*:				
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
999C*:				
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
999D*:				
Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Ves	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Hawick	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
999F*:				
Storden	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Hawick	Poor: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
1016, 1027. Udorthents				
1029*. Pits				
1052*:				
Okoboji	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Palms	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness, excess humus.
1829B, 1829C---------- Ridgeport Variant	Poor: depth to rock.	Improbable: thin layer.	Improbable: thin layer.	Poor: small stones.
1833---------- Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
1887---------- Millington	Poor: low strength.	Probable	Improbable: too sandy.	Good.
1909---------- Lemond	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
1911F*:				
Storden	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Ridgeport Variant	Poor: depth to rock, slope.	Improbable: thin layer.	Improbable: thin layer.	Poor: small stones, slope.
1912---------- Tilfer Variant	Poor: depth to rock, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: depth to rock, thin layer.
1917---------- Nishna	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
1919F*:				
Clarion	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Terril	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1928---------- Hanska	Fair: wetness.	Probable----------	Probable----------	Poor: area reclaim.
1929---------- Lemond	Fair: wetness.	Probable----------	Probable----------	Poor: area reclaim.
1930---------- Dickman	Good----------	Probable----------	Improbable: too sandy.	Fair: small stones, thin layer.
1931---------- Essexville	Poor: thin layer, wetness.	Improbable: thin layer.	Improbable: too sandy.	Poor: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
8B---------- Sparta	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Too sandy, soil blowing.	Droughty.
8C---------- Sparta	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope, droughty, fast intake.	Slope, too sandy, soil blowing.	Slope, droughty.
27A---------- Dickinson	Severe: seepage.	Severe: seepage.	Deep to water	Soil blowing---	Soil blowing, too sandy.	Favorable.
27B---------- Dickinson	Severe: seepage.	Severe: seepage.	Deep to water	Soil blowing, slope.	Soil blowing, too sandy.	Favorable.
31E, 31F---------- Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
35---------- Blue Earth	Moderate: seepage.	Severe: piping, excess humus, ponding.	Ponding, frost action.	Ponding--------	Ponding--------	Wetness.
41A---------- Estherville	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
41B---------- Estherville	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
85---------- Calco	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Wetness, flooding.	Wetness--------	Wetness.
86---------- Canisteo	Moderate: seepage.	Severe: wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.
94B---------- Terril	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope----------	Favorable------	Favorable.
94C---------- Terril	Severe: slope.	Moderate: piping.	Deep to water	Slope----------	Slope----------	Slope.
102B---------- Clarion	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
102B2---------- Clarion	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
113---------- Webster	Moderate: seepage.	Severe: wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.
114---------- Glencoe	Moderate: seepage.	Severe: hard to pack, excess humus, ponding.	Frost action, ponding.	Ponding--------	Ponding--------	Wetness.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
128B---------- Grogan	Severe: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
130---------- Nicollet	Moderate: seepage.	Moderate: piping, wetness.	Frost action---	Wetness--------	Wetness--------	Favorable.
134---------- Okoboji	Moderate: seepage.	Severe: ponding.	Ponding, frost action.	Ponding, erodes easily.	Ponding--------	Wetness.
136---------- Madelia	Moderate: seepage.	Severe: wetness, piping.	Frost action---	Wetness--------	Erodes easily, wetness.	Wetness, erodes easily.
140---------- Spicer	Moderate: seepage.	Severe: wetness.	Frost action---	Wetness--------	Wetness, erodes easily.	Wetness, erodes easily.
227---------- Lemond	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness--------	Wetness, too sandy.	Wetness.
247---------- Linder	Severe: seepage.	Severe: seepage, piping.	Frost action, cutbanks cave.	Wetness, droughty.	Wetness, too sandy.	Droughty.
269---------- Millington	Moderate: seepage.	Severe: piping, wetness.	Flooding, frost action.	Wetness, flooding.	Wetness--------	Wetness.
281---------- Darfur	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness--------	Wetness, too sandy.	Wetness.
282---------- Hanska	Severe: seepage.	Severe: seepage, wetness, piping.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Wetness.
313---------- Spillville	Moderate: seepage.	Moderate: piping, wetness.	Deep to water	Flooding-------	Favorable------	Favorable.
317---------- Oshawa	Slight---------	Severe: ponding.	Ponding, flooding, frost action.	Ponding, flooding.	Ponding--------	Wetness.
327A---------- Dickman	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
327B---------- Dickman	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
336---------- Delft	Slight---------	Severe: wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.
386---------- Okoboji	Moderate: seepage.	Severe: ponding.	Ponding, frost action.	Ponding--------	Ponding--------	Wetness.
421B---------- Ves	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
421B2---------- Ves	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
423---------- Seaforth	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable------	Favorable------	Favorable.
446---------- Normania	Moderate: seepage.	Moderate: piping, wetness.	Frost action---	Wetness--------	Wetness--------	Favorable.
463---------- Minneiska	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, flooding.	Soil blowing---	Favorable.
487---------- Hoopeston	Severe: seepage.	Severe: seepage, piping.	Frost action, cutbanks cave.	Wetness, soil blowing, rooting depth.	Wetness, too sandy, soil blowing.	Favorable.
495---------- Zumbro	Severe: seepage.	Severe: seepage, piping.	Deep to water	Fast intake, soil blowing.	Too sandy, soil blowing.	Favorable.
499---------- Hanska	Severe: seepage.	Severe: seepage, ponding.	Ponding, frost action, cutbanks cave.	Ponding--------	Ponding, too sandy.	Wetness.
518---------- Kalmarville	Severe: seepage.	Severe: piping, wetness.	Flooding, frost action.	Wetness, soil blowing, flooding.	Wetness, soil blowing.	Wetness.
539---------- Palms	Severe: seepage.	Severe: excess humus, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
574---------- Du Page	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Flooding-------	Favorable------	Favorable.
575---------- Nishna	Slight---------	Severe: hard to pack, wetness.	Flooding, percs slowly.	Slow intake, wetness, percs slowly.	Wetness, percs slowly, erodes easily.	Wetness, percs slowly, erodes easily.
603---------- Hanlon	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, flooding.	Soil blowing---	Favorable.
611B---------- Hawick	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, slope.	Too sandy, soil blowing.	Droughty.
611C---------- Hawick	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
639---------- Ridgeport	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, rooting depth.	Soil blowing---	Rooting depth.
820B*: Dickman----------	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
820B*:						
Clarion----------	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
919*:						
Lemond----------	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness--------	Wetness, too sandy.	Wetness.
Canisteo---------	Moderate: seepage.	Severe: wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.
920B*:						
Clarion----------	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
Estherville------	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
Storden----------	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
920C*:						
Clarion----------	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
Estherville------	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
Storden----------	Severe: slope.	Moderate: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
921B2*:						
Clarion----------	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
Storden----------	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
921C2*:						
Clarion----------	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
Storden----------	Severe: slope.	Moderate: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
923E*:						
Copaston---------	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Rock outcrop.						

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
929*:						
Fieldon	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.
Canisteo	Moderate: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
946*:						
Dickman	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
Nicollet	Moderate: seepage.	Moderate: piping.	Frost action	Wetness	Wetness	Favorable.
954B2*:						
Ves	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Storden	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
954C2*:						
Ves	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
954D2*:						
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Ves	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
960D2*:						
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Clarion	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
968*:						
Hanska	Severe: seepage.	Severe: seepage, wetness, piping.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Wetness.
Webster	Moderate: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
999B*:						
Ves	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
999B*:						
Storden	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Estherville	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
999C*:						
Ves	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Estherville	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
999D*:						
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Ves	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Hawick	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
999F*:						
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Hawick	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Droughty, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
1016, 1027. Udorthents						
1029*. Pits						
1052*:						
Okoboji	Slight	Severe: ponding.	Ponding, frost action.	Ponding, erodes easily.	Erodes easily, ponding.	Wetness.
Palms	Severe: seepage.	Severe: excess humus, ponding.	Ponding, subsides, frost action.	Ponding, soil blowing.	Ponding, soil blowing.	Wetness.
1829B Ridgeport Variant	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, depth to rock.	Depth to rock, too sandy.	Droughty, depth to rock.
1829C Ridgeport Variant	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, depth to rock.	Slope, depth to rock, too sandy.	Slope, droughty, depth to rock.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
1833---------- Coland	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Wetness, flooding.	Wetness--------	Wetness.
1887---------- Millington	Severe: seepage.	Severe: thin layer, wetness.	Flooding, frost action.	Wetness, flooding.	Wetness--------	Wetness.
1909---------- Lemond	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, frost action, cutbanks cave.	Ponding--------	Ponding, too sandy.	Wetness.
1911F*: Storden----------	Severe: slope.	Moderate: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
Ridgeport Variant	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, depth to rock.	Slope, depth to rock, too sandy.	Slope, droughty, depth to rock.
1912---------- Tilfer Variant	Moderate: seepage, depth to rock.	Severe: wetness.	Depth to rock, frost action.	Wetness, depth to rock.	Depth to rock, wetness.	Wetness, depth to rock.
1917---------- Nishna	Slight---------	Severe: hard to pack, ponding.	Ponding, percs slowly, flooding.	Ponding, slow intake, percs slowly.	Erodes easily, ponding, percs slowly.	Wetness, erodes easily, percs slowly.
1919F*: Clarion----------	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
Terril----------	Severe: slope.	Moderate: piping.	Deep to water	Slope----------	Slope----------	Slope.
1928---------- Hanska	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness--------	Wetness, too sandy.	Wetness.
1929---------- Lemond	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness--------	Wetness, too sandy.	Wetness.
1930---------- Dickman	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
1931---------- Essexville	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
8B, 8C---------- Sparta	0-15	Loamy sand-------	SM	A-2, A-4	0	85-100	85-100	50-95	15-50	---	NP
	15-38	Loamy fine sand, fine sand, sand.	SP-SM, SM	A-2, A-3, A-4	0	85-100	85-100	50-95	5-50	---	NP
	38-60	Sand, fine sand	SP-SM, SM, SP	A-2, A-3	0	85-100	85-100	50-95	2-30	---	NP
27A, 27B--------- Dickinson	0-18	Sandy loam-------	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	30-50	15-30	NP-10
	18-24	Fine sandy loam, sandy loam.	SM, SC, SM-SC	A-4	0	100	100	85-95	35-50	15-30	NP-10
	24-40	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM, SM-SC	A-2, A-3	0	100	100	80-95	5-20	10-20	NP-5
	40-60	Sand, loamy fine sand, loamy sand.	SM, SP-SM	A-3, A-2	0	100	100	70-90	5-20	---	NP
31E, 31F--------- Storden	0-10	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	10-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
35---------- Blue Earth	0-10	Mucky silt loam	OL, ML	A-5	0	95-100	95-100	85-95	80-95	41-50	2-8
	10-60	Mucky silty clay loam, clay loam, mucky silt loam.	OL, ML	A-5	0	95-100	80-100	80-95	80-95	41-50	2-8
41A, 41B--------- Estherville	0-11	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-100	50-75	25-50	20-30	2-10
	11-16	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	16-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM, GP	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
85---------- Calco	0-42	Silty clay loam, silt loam.	CH, CL	A-7	0	100	100	95-100	85-100	40-60	15-30
	42-60	Silty clay loam, silt loam, clay loam.	CL, CH	A-7	0	100	100	95-100	85-100	40-60	15-30
86---------- Canisteo	0-18	Clay loam--------	OL, CL	A-7	0	98-100	95-100	85-98	60-90	40-50	15-20
	18-42	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	98-100	90-100	85-95	65-85	38-50	25-35
	42-60	Clay loam, loam, fine sandy loam.	CL	A-6	0-5	95-100	90-98	80-95	50-75	30-40	12-20
94B, 94C--------- Terril	0-35	Loam-------------	CL	A-6	0-5	95-100	95-100	70-90	60-80	30-40	10-20
	35-60	Clay loam, loam	CL	A-6	0-5	95-100	90-100	85-95	65-85	25-40	10-20
102B, 102B2------ Clarion	0-15	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	15-34	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	34-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
113---------- Webster	0-20	Clay loam--------	CL, CH	A-7, A-6	0-5	95-100	95-100	85-95	70-90	35-60	15-30
	20-42	Clay loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	15-30
	42-60	Loam, sandy loam, clay loam.	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
114---------- Glencoe	0-38	Silty clay loam, clay loam.	OL, OH, MH, ML	A-6, A-7	0	95-100	90-100	75-100	60-90	30-55	10-25
	38-51	Loam, clay loam, silty clay loam.	CL	A-6, A-7	0	95-100	90-100	75-100	60-90	30-50	10-25
	51-60	Loam, clay loam	CL, ML	A-6, A-7	0	90-100	85-100	60-95	55-75	30-50	10-20
128B---------- Grogan	0-14	Silt loam--------	ML	A-4	0	100	100	95-100	70-90	20-40	NP-10
	14-26	Loam, silt loam	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	26-60	Stratified loamy very fine sand to silt loam.	ML	A-4	0	100	100	90-100	65-95	20-30	NP-5
130---------- Nicollet	0-17	Clay loam--------	ML, CL	A-6, A-7	0-5	95-100	90-100	85-98	55-85	35-50	10-25
	17-36	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-80	35-50	15-25
	36-60	Loam, clay loam	CL	A-6	0-5	95-100	90-100	75-90	50-75	30-40	15-25
134---------- Okoboji	0-10	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	10-42	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	42-50	Silty clay loam	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
	50-60	Stratified loam to silty clay loam.	CL, CH	A-7	0-5	95-100	90-100	90-100	75-90	40-55	20-30
136---------- Madelia	0-19	Silty clay loam	ML	A-7	0	100	100	100	90-100	40-50	10-20
	19-28	Silty clay loam, silt loam.	CL	A-7, A-6	0	100	100	100	90-100	30-50	10-25
	28-60	Silt loam, silty clay loam, loam.	ML, CL	A-6, A-4, A-7	0	100	100	100	90-100	30-50	5-25
140---------- Spicer	0-23	Silty clay loam	ML	A-7, A-6	0	100	100	95-100	90-100	35-50	10-20
	23-45	Silt loam, silty clay loam.	ML	A-7, A-6	0	100	100	95-100	85-100	35-50	10-20
	45-60	Silt loam, silty clay loam.	ML	A-4, A-6	0	100	100	95-100	85-100	30-40	5-12
227---------- Lemond	0-18	Loam, sandy loam	ML, CL, CL-ML	A-4	0	95-100	95-100	80-95	50-65	<25	2-10
	18-29	Sandy loam, loam, coarse sandy loam.	SM, SM-SC	A-2, A-4	0	95-100	95-100	65-80	25-50	<25	NP-7
	29-60	Sand, coarse sand, loamy sand.	SP-SM, SP	A-3, A-1, A-2	0	90-100	85-100	35-85	2-10	---	NP
247---------- Linder	0-13	Sandy loam-------	CL, SC	A-4, A-6	0	100	95-100	80-95	35-80	25-40	8-15
	13-21	Sandy loam-------	SC, SM-SC	A-2, A-4	0	95-100	80-100	45-75	30-45	20-30	5-10
	21-60	Gravelly sand, gravelly coarse sand.	SP, SP-SM	A-1	0-5	75-95	30-95	25-50	2-12	---	NP
269---------- Millington	0-38	Clay loam--------	CL, ML, OL	A-7, A-6	0	100	90-100	90-100	90-100	35-50	11-20
	38-60	Stratified sandy loam to silty clay loam.	CL, CL-ML	A-6, A-7, A-4	0	80-100	80-100	80-100	60-95	20-45	5-20
281---------- Darfur	0-19	Loam----------	OL, ML	A-4	0	100	100	100	60-80	25-40	NP-10
	19-35	Fine sandy loam, loam, loamy fine sand.	SM	A-4	0	100	100	70-100	35-50	20-30	NP-5
	35-60	Stratified fine sand to fine sandy loam.	SM	A-2, A-4	0	100	100	50-100	15-40	---	---

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
282---------- Hanska	0-16	Sandy loam-------	SM, SM-SC	A-4	0	95-100	95-100	80-95	35-50	<25	NP-5
	16-25	Sandy loam, coarse sandy loam, loam.	SM, SM-SC, SC	A-4	0	95-100	95-100	65-80	35-50	<20	2-8
	25-60	Sand, coarse sand	SP-SM	A-3, A-1, A-2	0	95-100	85-100	45-70	5-10	<20	NP
313---------- Spillville	0-54	Loam------------	CL	A-6	0	100	95-100	85-95	60-80	25-40	10-20
	54-60	Clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
317---------- Oshawa	0-35	Silty clay loam, clay loam.	MH, CH	A-7	0	95-100	95-100	95-100	90-100	50-70	20-40
	35-60	Loam, silt loam, silty clay loam.	CL	A-6	0	95-100	95-100	90-100	85-95	30-40	10-15
327A, 327B------- Dickman	0-11	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0	95-100	95-100	55-95	25-40	20-30	2-8
	11-19	Sandy loam, fine sandy loam, loamy sand.	SM, SM-SC, SC	A-2, A-4	0	95-100	85-100	55-95	25-45	15-25	2-8
	19-60	Stratified fine sand to coarse sand.	SP-SM	A-3, A-2	0	95-100	75-100	50-80	5-10	---	NP
336---------- Delft	0-48	Clay loam--------	CL	A-6, A-7	0	95-100	90-98	75-90	60-80	30-45	10-20
	48-60	Loam, clay loam, sandy loam.	CL, ML, CL-ML	A-6, A-4	0-5	90-100	85-100	55-90	50-85	20-40	3-15
386---------- Okoboji	0-10	Sapric material	PT	A-8	0	---	---	---	---	---	---
	10-38	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	38-52	Silty clay loam, silty clay.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
	52-60	Stratified loam to silty clay loam.	CL, CH	A-7	0-5	95-100	90-100	90-100	75-90	40-55	20-30
421B, 421B2------ Ves	0-13	Loam------------	CL, ML	A-6, A-4, A-7	0-5	95-100	90-100	80-100	60-80	30-50	7-20
	13-24	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-75	30-50	10-20
	24-60	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
423---------- Seaforth	0-11	Loam------------	ML, CL-ML, CL	A-6, A-4	0-5	95-100	90-100	80-100	60-80	25-40	5-15
	11-26	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	85-100	80-95	55-80	30-40	8-15
	26-60	Loam------------	CL, ML	A-6, A-4	0-5	90-100	85-95	80-90	55-80	30-40	8-15
446---------- Normania	0-14	Loam------------	CL	A-6, A-4	0-5	95-100	90-100	80-100	60-80	30-40	8-15
	14-27	Loam, clay loam	CL	A-6, A-4	0-5	95-100	90-100	80-95	55-85	25-40	8-20
	27-60	Loam, clay loam	CL	A-6, A-4	0-5	90-100	85-100	80-90	55-80	30-40	8-15
463---------- Minneiska	0-10	Sandy loam-------	SM	A-4	0	100	95-100	50-70	35-50	<20	NP-4
	10-60	Stratified silt loam to sand.	SM, ML	A-4	0	100	85-100	50-90	35-60	20-30	NP-5
487---------- Hoopeston	0-15	Sandy loam-------	SM	A-2, A-4	0	90-100	90-100	70-90	25-45	20-35	NP-10
	15-24	Sandy loam, fine sandy loam.	SM, SC, SM-SC	A-2, A-4	0	90-100	90-100	60-85	25-50	<30	NP-10
	24-60	Loamy sand, sand, loamy fine sand.	SP-SM, SM, SC, SM-SC	A-2, A-3	0	90-100	90-100	50-80	5-20	<25	NP-10

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
495---------- Zumbro	0-10	Loamy sand-------	SM	A-2	0	100	95-100	60-95	15-35	<20	NP
	10-37	Loamy sand, loamy fine sand.	SM	A-2	0	100	95-100	60-95	15-30	<20	NP
	37-53	Sand, fine sand, loamy sand.	SP, SM, SP-SM	A-2, A-3	0	95-100	85-100	60-95	4-30	<20	NP
	53-60	Sand, fine sand, coarse sand.	SP, SM, SP-SM	A-2, A-3	0	90-100	75-100	50-80	4-20	<20	NP
499---------- Hanska	0-30	Loam-------------	ML, CL, CL-ML	A-4	0	95-100	95-100	80-95	50-65	<25	2-10
	30-37	Sandy loam, loamy sand.	SM, SC, SM-SC	A-4	0	95-100	95-100	65-80	36-50	<25	NP-8
	37-60	Sand, coarse sand	SP-SM	A-3, A-1, A-2	0	95-100	85-100	45-70	5-10	<20	NP
518---------- Kalmarville	0-15	Sandy loam-------	SM	A-4	0	95-100	90-100	60-85	35-50	<25	NP-4
	15-60	Stratified gravelly coarse sand to sandy loam.	SM, SM-SC	A-4, A-2	0	95-100	90-100	60-85	30-50	15-25	NP-5
539---------- Palms	0-22	Sapric material	PT	A-8	---	---	---	---	---	---	---
	22-60	Clay loam, silty clay loam, silt loam.	CL-ML, CL	A-4, A-6	0	85-100	80-100	70-95	50-90	25-40	5-20
574---------- Du Page	0-60	Loam-------------	CL	A-6, A-7	0	95-100	95-100	90-100	70-95	30-45	11-21
575---------- Nishna	0-39	Silty clay-------	CH, MH	A-7	0	100	100	95-100	90-100	55-65	25-35
	39-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	90-100	60-70	30-40
603---------- Hanlon	0-44	Sandy loam-------	SM-SC, SC, SM	A-4	0	100	100	75-80	35-50	25-35	5-10
	44-57	Sandy loam, fine sandy loam, loamy fine sand.	SM-SC, SC	A-4, A-2	0	100	100	75-80	25-40	15-25	5-10
	57-60	Loam, sandy loam, loamy sand.	SC, CL, SM-SC, CL-ML	A-4, A-6, A-2	0	100	100	80-90	20-60	15-35	5-15
611B, 611C------- Hawick	0-9	Coarse sandy loam	SM	A-2	0-5	85-100	80-95	50-65	25-35	<20	NP-4
	9-16	Gravelly loamy coarse sand, gravelly coarse sand, loamy sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	16-60	Gravelly coarse sand, coarse sand, sand.	SP, SP-SM	A-1, A-3, A-2	0-5	60-95	50-95	30-65	2-10	---	NP
639---------- Ridgeport	0-12	Sandy loam-------	SM, SC, SM-SC	A-2, A-4	0	95-100	90-100	70-90	25-50	15-30	2-10
	12-27	Sandy loam, coarse sandy loam, fine sandy loam.	SM, SC, SM-SC	A-2, A-4	0	95-100	85-100	65-85	20-45	15-30	2-10
	27-60	Gravelly coarse sand, gravelly sand, sand.	SW, SP, SW-SM, SP-SM	A-1	0-5	80-95	75-95	35-50	2-10	<25	NP-6

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
820B*:											
Dickman---------	0-11	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0	95-100	95-100	55-95	25-40	20-30	2-8
	11-17	Sandy loam, fine sandy loam.	SM, SM-SC, SC	A-2, A-4	0	95-100	85-100	55-95	25-45	15-25	2-8
	17-60	Stratified fine sand to coarse sand.	SP-SM	A-3, A-2	0	95-100	75-100	50-80	5-10	---	NP
Clarion---------	0-13	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	13-28	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	28-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
919*:											
Lemond----------	0-15	Loam-------------	ML, CL, CL-ML	A-4	0	95-100	95-100	80-95	50-65	<25	2-10
	15-27	Sandy loam, loamy sand, loam.	SM, SM-SC	A-2, A-4	0	95-100	95-100	65-80	25-50	<25	NP-7
	27-60	Sand, coarse sand, loamy sand.	SP-SM, SP	A-3, A-1, A-2	0	90-100	85-100	35-85	2-10	---	NP
Canisteo--------	0-16	Clay loam--------	OL, CL	A-7	0	98-100	95-100	85-98	60-90	40-50	15-20
	16-35	Clay loam, loam, sandy loam.	CL, ML, SM, SC	A-6, A-4	0-5	90-100	80-95	60-90	40-80	30-40	5-15
	35-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	50-75	30-40	12-20
920B*, 920C*:											
Clarion---------	0-10	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	10-23	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	23-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
Estherville-----	0-10	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-100	50-75	25-50	20-30	2-10
	10-15	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	15-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM, GP	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
Storden---------	0-10	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	10-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
921B2*, 921C2*:											
Clarion---------	0-10	Loam-------------	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	10-25	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	25-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
Storden---------	0-10	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	10-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
923E*:											
Copaston--------	0-16	Loam-------------	SM, ML	A-4	0	95-100	90-100	65-80	45-80	30-40	NP-10
	16	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
923E*:											
Rock outcrop.											
929*:											
Fieldon	0-20	Loam	CL-ML, CL, ML	A-4	0	100	100	85-95	50-75	20-32	NP-10
	20-31	Fine sandy loam, very fine sandy loam, loam.	ML, SM	A-4	0	100	100	70-90	35-60	<30	NP-5
	31-60	Stratified fine sand to fine sandy loam.	SM	A-2, A-4	0	100	100	60-100	15-40	---	NP
Canisteo	0-17	Clay loam	OL, CL	A-7	0	98-100	95-100	85-98	60-90	40-50	15-20
	17-28	Clay loam, loam, sandy loam.	CL, ML, SM, SC	A-6, A-4	0-5	90-100	80-95	60-90	40-80	30-40	5-15
	28-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	50-75	30-40	12-20
946*:											
Dickman	0-14	Sandy loam	SM, SM-SC, SC	A-2, A-4	0	95-100	95-100	55-95	25-40	20-30	2-8
	14-18	Loamy sand, sandy loam.	SM, SM-SC, SC	A-2, A-4	0	95-100	85-100	55-95	25-45	15-25	2-8
	18-60	Stratified fine sand to coarse sand.	SP-SM	A-3, A-2	0	95-100	75-100	50-80	5-10	---	NP
Nicollet	0-16	Clay loam	ML, CL	A-6, A-7	0-5	95-100	90-100	85-98	55-85	35-50	10-25
	16-29	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-80	35-50	15-25
	29-60	Loam, clay loam	CL	A-6	0-5	95-100	90-100	75-90	50-75	30-40	15-25
954B2*, 954C2*:											
Ves	0-10	Loam	CL, ML	A-6, A-4, A-7	0-5	95-100	90-100	80-100	60-80	30-50	7-20
	10-19	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-75	30-50	10-20
	19-60	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
Storden	0-8	Loam	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	8-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
954D2*:											
Storden	0-9	Loam	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	9-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
Ves	0-9	Loam	CL, ML	A-6, A-4, A-7	0-5	95-100	90-100	80-100	60-80	30-50	7-20
	9-18	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-75	30-50	10-20
	18-60	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
960D2*:											
Storden	0-10	Loam	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	10-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
Clarion	0-10	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	10-18	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	18-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
968*:											
Hanska----------	0-18	Sandy loam-------	SM, SM-SC	A-4	0	95-100	95-100	80-95	35-50	<25	NP-5
	18-23	Sandy loam, coarse sandy loam, loam.	SM, SM-SC, SC	A-4	0	95-100	95-100	65-80	35-50	<20	2-8
	23-29	Loamy sand, loamy coarse sand.	SP-SM, SM	A-2, A-3	0	95-100	90-100	50-75	5-25	<20	NP
	29-60	Sand, coarse sand	SP-SM	A-3, A-1, A-2	0	95-100	85-100	45-70	5-10	<20	NP
Webster---------	0-16	Loam-------------	CL, CH	A-7, A-6	0-5	95-100	95-100	85-95	70-90	35-60	15-30
	16-26	Clay loam, silty clay loam, loam.	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	15-30
	26-60	Loam, sandy loam, clay loam.	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20
999B*, 999C*:											
Ves----------	0-10	Loam-------------	CL, ML	A-6, A-4, A-7	0-5	95-100	90-100	80-100	60-80	30-50	7-20
	10-26	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-75	30-50	10-20
	26-60	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
Storden---------	0-9	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	9-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
Estherville-----	0-10	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-100	50-75	25-50	20-30	2-10
	10-15	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	15-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM, GP	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
999D*:											
Storden---------	0-9	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	9-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
Ves----------	0-10	Loam-------------	CL, ML	A-6, A-4, A-7	0-5	95-100	90-100	80-100	60-80	30-50	7-20
	10-19	Loam, clay loam	CL	A-6, A-7	0-5	95-100	90-100	80-95	55-75	30-50	10-20
	19-60	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
Hawick----------	0-10	Loamy sand-------	SM, SP-SM	A-2, A-1	0-5	85-100	80-95	40-70	10-25	---	NP
	10-16	Gravelly loamy coarse sand, gravelly coarse sand, loamy sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	16-60	Gravelly coarse sand, coarse sand, sand.	SP, SP-SM	A-1, A-3, A-2	0-5	60-95	50-95	30-65	2-10	---	NP
999F*:											
Storden---------	0-8	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	8-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
999F*:											
Hawick----------	0-11	Loamy coarse sand	SM, SP-SM	A-2, A-1	0-5	85-100	80-95	40-70	10-25	---	NP
	11-21	Gravelly loamy coarse sand, gravelly coarse sand, loamy sand.	SP-SM, SM	A-1, A-2, A-3	0-5	75-95	60-95	35-70	5-25	---	NP
	21-60	Gravelly coarse sand, coarse sand, sand.	SP, SP-SM	A-1, A-3, A-2	0-5	60-95	50-95	30-65	2-10	---	NP
1016, 1027. Udorthents											
1029*. Pits											
1052*:											
Okoboji---------	0-13	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	13-29	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	29-60	Silty clay loam, silty clay.	CH	A-7	0	95-100	95-100	90-100	80-95	55-65	30-40
Palms----------	0-23	Sapric material	PT	A-8	---	---	---	---	---	---	---
	23-60	Clay loam, silty clay loam, fine sandy loam.	CL-ML, CL	A-4, A-6	0	85-100	80-100	70-95	50-90	25-40	5-20
1829B, 1829C----- Ridgeport Variant	0-9	Loam----------	ML, SM, CL, SC	A-4, A-2	0-5	85-100	80-100	50-95	30-65	<25	2-10
	9-16	Sandy loam, gravelly sandy loam, loam.	SM, ML, CL, SC	A-2, A-4	0-5	85-100	75-100	40-85	25-55	<25	2-8
	16-25	Gravelly coarse sand, coarse sand, loamy coarse sand.	SP, SP-SM, SM, GP	A-1, A-2, A-3	0-10	55-90	50-85	25-65	2-25	<20	NP
	25-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
1833---------- Coland	0-10	Clay loam--------	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	10-46	Clay loam, silty clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	46-60	Loam, sandy loam, sandy clay loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0	100	90-100	60-70	40-60	20-40	5-15
1887---------- Millington	0-9	Clay loam--------	CL, ML, OL	A-7, A-6	0	100	100	90-100	90-100	35-50	12-20
	9-41	Loam, clay loam, sandy loam.	CL	A-7, A-6	0	100	100	80-100	70-95	28-50	10-22
	41-60	Stratified fine sand to coarse sand.	SP, SP-SM	A-2, A-3	0-5	95-100	75-100	50-60	5-10	---	NP
1909---------- Lemond	0-30	Loam----------	ML, SM, CL, SC	A-4	0	95-100	95-100	80-95	40-65	<25	2-10
	30-36	Sandy loam, loamy sand.	SM, SM-SC	A-2, A-4	0	95-100	95-100	65-80	25-40	<25	NP-7
	36-60	Sand, coarse sand, loamy sand.	SP-SM, SP	A-3, A-1, A-2	0	90-100	85-100	35-85	2-10	---	NP

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
1911F*:											
Storden	0-6	Loam	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	6-60	Loam, clay loam	CL-ML, CL, ML	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
Ridgeport Variant	0-14	Loam	ML, SM, CL, SC	A-4, A-2	0-5	85-100	80-100	50-95	30-65	<25	2-10
	14-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
1912 Tilfer Variant	0-20	Clay loam	CL, CH	A-7, A-6	0	95-100	95-100	80-95	60-90	35-54	15-25
	20-32	Clay loam, loam	CL	A-6, A-7	0	95-100	95-100	80-95	60-80	30-50	10-25
	32-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
1917 Nishna	0-26	Silty clay	CH, MH	A-7	0	100	100	95-100	90-100	55-65	25-35
	26-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	90-100	60-70	30-40
1919F*:											
Clarion	0-15	Loam	CL, CL-ML	A-4, A-6	0-5	95-100	95-100	75-90	50-75	25-40	5-15
	15-37	Loam, clay loam	CL, CL-ML	A-4, A-6	0-5	90-100	85-100	75-90	50-75	25-40	5-15
	37-60	Loam, sandy loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	45-70	25-40	5-15
Terril	0-31	Loam	CL	A-6	0-5	95-100	95-100	70-90	60-80	30-40	10-20
	31-60	Clay loam, loam	CL	A-6	0-5	95-100	90-100	85-95	65-85	25-40	10-20
1928 Hanska	0-18	Loam	ML, CL, CL-ML	A-4	0	98-100	95-100	80-95	50-65	<25	2-10
	18-26	Loam, sandy loam	SM, SM-SC, SC	A-4	0	98-100	95-100	65-80	35-50	<20	2-8
	26-31	Loamy sand, loamy coarse sand.	SP-SM, SM	A-2, A-3	0	98-100	90-100	50-75	5-25	<20	NP
	31-60	Gravelly coarse sand, gravelly sand.	SP-SM	A-1	0	65-95	45-85	20-40	5-10	<20	NP
1929 Lemond	0-18	Loam	ML, CL, CL-ML	A-4	0	98-100	95-100	80-95	50-65	<25	2-10
	18-27	Loam, sandy loam, loamy sand.	SM, SM-SC	A-2, A-4	0	98-100	95-100	65-80	25-50	<25	NP-7
	27-60	Gravelly coarse sand, gravelly sand.	SP-SM, SP	A-1	0	65-95	45-85	20-45	2-10	---	NP
1930 Dickman	0-15	Sandy loam	SM, SM-SC, SC	A-2, A-4	0	95-100	95-100	55-95	25-40	20-30	2-8
	15-24	Loamy sand, sandy loam.	SM, SM-SC, SC	A-2, A-4	0	95-100	85-100	55-95	25-45	15-25	2-8
	24-60	Stratified fine sand to coarse sand.	SP-SM	A-3, A-2	0	95-100	75-100	50-80	5-10	---	NP
1931 Essexville	0-9	Sandy loam	SM, SM-SC	A-4	0	100	95-100	60-90	35-50	<25	NP-7
	9-23	Loamy sand, loamy fine sand, fine sand.	SM, SM-SC, SP-SM	A-1-b, A-2-4, A-3, A-4	0	90-100	80-100	40-85	5-45	<25	NP-7
	23-60	Loam, clay loam	CL	A-4, A-6	0	95-100	90-100	80-95	55-90	20-38	8-25

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
8B, 8C	0-15	3-10	1.20-1.40	2.0-6.0	0.09-0.12	5.1-7.3	Low	0.17	5	2	1-2
Sparta	15-38	1-8	1.40-1.60	6.0-20	0.05-0.11	6.1-7.8	Low	0.15			
	38-60	0-5	1.50-1.70	6.0-20	0.04-0.07	6.1-8.4	Low	0.15			
27A, 27B	0-18	10-18	1.50-1.55	2.0-6.0	0.12-0.15	5.6-7.3	Low	0.20	4	3	2-4
Dickinson	18-24	10-15	1.45-1.55	2.0-6.0	0.12-0.15	5.1-6.5	Low	0.20			
	24-40	4-10	1.55-1.65	6.0-20	0.08-0.10	5.1-6.5	Low	0.20			
	40-60	4-10	1.60-1.70	6.0-20	0.02-0.04	5.6-7.3	Low	0.15			
31E, 31F	0-10	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	4L	1-2
Storden	10-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
35	0-10	18-27	0.20-0.80	0.6-2.0	0.18-0.24	7.4-8.4	Moderate	0.28	5	4L	10-25
Blue Earth	10-60	18-32	0.20-0.80	0.6-2.0	0.18-0.24	7.4-8.4	Low	0.28			
41A, 41B	0-11	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	Low	0.20	3	3	2-4
Estherville	11-16	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	Low	0.20			
	16-60	0-8	1.50-1.65	6.0-20	0.02-0.04	6.6-8.4	Low	0.10			
85	0-42	20-33	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	High	0.28	5	7	5-7
Calco	42-60	20-35	1.25-1.30	0.6-2.0	0.21-0.23	7.4-8.4	High	0.28			
86	0-18	27-32	1.25-1.35	0.6-2.0	0.18-0.22	7.4-8.4	Moderate	0.24	5	4L	4-8
Canisteo	18-42	20-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	Moderate	0.32			
	42-60	15-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low	0.32			
94B, 94C	0-35	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low	0.24	5	6	4-5
Terril	35-60	22-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	Low	0.32			
102B, 102B2	0-15	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.28	5	6	3-5
Clarion	15-34	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low	0.37			
	34-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
113	0-20	26-35	1.35-1.40	0.6-2.0	0.19-0.21	6.1-7.3	Moderate	0.24	5	6	6-7
Webster	20-42	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	Moderate	0.32			
	42-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate	0.32			
114	0-38	25-35	1.35-1.45	0.2-0.6	0.18-0.22	6.1-7.3	Moderate	0.28	5	6	5-10
Glencoe	38-51	25-35	1.35-1.50	0.2-0.6	0.15-0.19	6.6-7.8	Moderate	0.28			
	51-60	22-32	1.35-1.50	0.6-2.0	0.15-0.19	7.4-7.8	Low	0.28			
128B	0-14	8-18	1.25-1.40	2.0-6.0	0.22-0.24	6.1-7.3	Low	0.32	5	5	2-4
Grogan	14-26	8-18	1.40-1.50	2.0-6.0	0.17-0.19	6.1-7.8	Low	0.43			
	26-60	5-15	1.50-1.60	2.0-6.0	0.17-0.19	7.4-8.4	Low	0.43			
130	0-17	27-35	1.15-1.25	0.6-2.0	0.17-0.22	5.6-7.3	Moderate	0.24	5	6	4-8
Nicollet	17-36	24-35	1.25-1.35	0.6-2.0	0.15-0.19	5.6-7.8	Moderate	0.32			
	36-60	22-32	1.35-1.55	0.6-2.0	0.14-0.19	7.4-8.4	Low	0.32			
134	0-10	35-42	1.25-1.30	0.2-0.6	0.21-0.23	6.1-7.3	High	0.37	5	4	7-10
Okoboji	10-42	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.3	High	0.37			
	42-50	35-40	1.35-1.40	0.2-0.6	0.18-0.20	6.6-8.4	High	0.37			
	50-60	20-30	1.40-1.50	0.6-2.0	0.18-0.20	7.4-8.4	Moderate	0.28			
136	0-19	18-35	1.20-1.30	0.6-2.0	0.18-0.24	6.1-7.3	Moderate	0.28	5	6	4-8
Madelia	19-28	18-35	1.25-1.35	0.6-2.0	0.16-0.22	6.6-7.8	Moderate	0.28			
	28-60	18-35	1.30-1.40	0.6-2.0	0.16-0.22	7.4-8.4	Low	0.37			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
140----------	0-23	18-35	1.20-1.30	0.6-2.0	0.18-0.24	7.4-8.4	Moderate-----	0.28	5	4L	4-8
Spicer	23-45	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	Moderate-----	0.37			
	45-60	18-35	1.25-1.35	0.6-2.0	0.16-0.22	7.4-8.4	Low----------	0.37			
227----------	0-18	6-18	1.30-1.40	2.0-6.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L	4-8
Lemond	18-29	6-18	1.35-1.50	2.0-6.0	0.10-0.13	7.4-8.4	Low----------	0.28			
	29-60	1-10	1.50-1.70	6.0-20	0.05-0.07	7.4-8.4	Low----------	0.15			
247----------	0-13	14-18	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.24	4	5	3-5
Linder	13-21	10-18	1.45-1.55	2.0-6.0	0.15-0.17	6.1-7.3	Low----------	0.24			
	21-60	2-8	1.55-1.75	>20	0.02-0.04	7.4-8.4	Low----------	0.10			
269----------	0-38	27-35	1.40-1.60	0.6-2.0	0.17-0.23	7.4-8.4	Moderate-----	0.28	5	6	5-8
Millington	38-60	18-35	1.50-1.70	0.6-2.0	0.14-0.20	7.4-8.4	Moderate-----	0.28			
281----------	0-19	18-25	1.20-1.35	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.20	5	5	5-8
Darfur	19-35	13-18	1.35-1.50	2.0-6.0	0.15-0.17	6.6-7.8	Low----------	0.20			
	35-60	5-15	1.45-1.60	2.0-6.0	0.08-0.10	6.6-8.4	Low----------	0.20			
282----------	0-16	6-18	1.30-1.40	2.0-6.0	0.15-0.18	6.1-7.3	Low----------	0.28	4	3	4-8
Hanska	16-25	6-18	1.35-1.50	2.0-6.0	0.10-0.13	6.1-7.3	Low----------	0.28			
	25-60	1-10	1.50-1.60	6.0-20	0.03-0.05	6.6-7.8	Low----------	0.17			
313----------	0-54	18-26	1.45-1.55	0.6-2.0	0.19-0.21	6.1-7.3	Moderate-----	0.28	5	6	4-6
Spillville	54-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	6.1-7.3	Low----------	0.28			
317----------	0-35	28-35	1.15-1.30	0.2-0.6	0.18-0.22	7.4-7.8	Moderate-----	0.28	5	8	4-10
Oshawa	35-60	18-35	1.30-1.35	0.2-0.6	0.17-0.19	7.4-7.8	Low----------	0.28			
327A, 327B-------	0-11	6-18	1.30-1.40	2.0-6.0	0.13-0.15	5.6-6.5	Low----------	0.20	3	3	2-4
Dickman	11-19	6-18	1.35-1.50	2.0-6.0	0.12-0.14	5.6-7.3	Low----------	0.20			
	19-60	1-10	1.50-1.60	6.0-20	0.02-0.07	6.1-7.8	Low----------	0.15			
336----------	0-48	27-35	1.40-1.65	0.2-0.6	0.18-0.20	5.6-7.8	Moderate-----	0.24	5	6	4-8
Delft	48-60	15-32	1.40-1.55	0.2-0.6	0.15-0.19	6.6-8.4	Low----------	0.32			
386----------	0-10	---	0.25-0.45	0.2-0.6	0.35-0.45	6.1-7.8	----------	----	5	2	>28
Okoboji	10-38	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High---------	0.37			
	38-52	35-45	1.35-1.40	0.2-0.6	0.18-0.20	7.4-8.4	High---------	0.37			
	52-60	20-30	1.40-1.50	0.6-2.0	0.18-0.20	7.4-8.4	Moderate-----	0.28			
421B, 421B2------	0-13	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	5	6	2-6
Ves	13-24	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.6-7.8	Moderate-----	0.24			
	24-60	20-32	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37			
423----------	0-11	20-27	1.30-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Moderate-----	0.28	5	4L	3-6
Seaforth	11-26	20-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.28			
	26-60	20-27	1.35-1.60	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.28			
446----------	0-14	22-32	1.20-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Moderate-----	0.24	5	6	4-8
Normania	14-27	22-32	1.30-1.40	0.6-2.0	0.17-0.19	6.1-7.8	Moderate-----	0.24			
	27-60	22-32	1.40-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.32			
463----------	0-10	5-18	1.35-1.50	2.0-6.0	0.15-0.18	7.4-8.4	Low----------	0.20	5	3	2-5
Minneiska	10-60	5-18	1.40-1.60	2.0-6.0	0.13-0.18	7.4-8.4	Low----------	0.28			
487----------	0-15	8-18	1.35-1.70	2.0-6.0	0.12-0.15	5.6-7.3	Low----------	0.20	4	3	3-5
Hoopeston	15-24	12-18	1.45-1.75	2.0-6.0	0.12-0.17	6.1-7.3	Low----------	0.28			
	24-60	2-10	1.50-1.80	6.0-20	0.05-0.10	6.1-7.8	Low----------	0.17			

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
495----------	0-10	2-10	1.45-1.55	6.0-20	0.10-0.12	5.6-7.8	Low----------	0.17	5	2	1-2
Zumbro	10-37	2-10	1.45-1.55	6.0-20	0.10-0.12	5.6-7.8	Low----------	0.17			
	37-53	0-10	1.45-1.60	6.0-20	0.05-0.12	6.1-7.8	Low----------	0.17			
	53-60	0-5	1.55-1.65	6.0-20	0.05-0.08	6.1-7.8	Low----------	0.17			
499----------	0-30	6-18	1.30-1.50	2.0-6.0	0.20-0.22	6.1-7.3	Low----------	0.28	5	5	4-8
Hanska	30-37	6-18	1.40-1.60	2.0-6.0	0.10-0.13	6.1-7.3	Low----------	0.28			
	37-60	1-10	1.50-1.70	6.0-20	0.05-0.07	6.1-7.8	Low----------	0.15			
518----------	0-15	8-15	1.35-1.50	2.0-6.0	0.13-0.18	6.6-7.8	Low----------	0.20	5	3	2-4
Kalmarville	15-60	8-18	1.40-1.50	2.0-6.0	0.13-0.18	6.6-7.8	Low----------	0.20			
539----------	0-22	---	0.25-0.45	0.6-2.0	0.35-0.45	6.1-7.3	----------	----	2	2	>28
Palms	22-60	7-35	1.45-1.75	0.2-0.6	0.14-0.22	6.6-7.8	Low----------	----			
574----------	0-60	18-27	1.40-1.60	0.6-2.0	0.22-0.24	6.6-8.4	Moderate-----	0.28	5	6	4-6
Du Page											
575----------	0-39	36-44	1.30-1.35	0.06-0.2	0.12-0.14	6.6-8.4	High----------	0.37	5	4	4-6
Nishna	39-60	38-46	1.35-1.40	0.06-0.2	0.11-0.13	7.4-8.4	High----------	0.28			
603----------	0-44	12-18	1.45-1.55	2.0-6.0	0.16-0.18	6.1-7.3	Low----------	0.20	5	3	4-6
Hanlon	44-57	5-10	1.55-1.70	2.0-6.0	0.11-0.13	5.6-7.3	Low----------	0.20			
	57-60	2-18	1.55-1.70	2.0-6.0	0.12-0.19	6.6-7.8	Low----------	0.20			
611B, 611C-------	0-9	5-15	1.35-1.55	2.0-6.0	0.13-0.15	6.1-7.8	Low----------	0.17	3	3	1-4
Hawick	9-16	1-10	1.50-1.65	>6.0	0.03-0.10	6.1-7.8	Low----------	0.10			
	16-60	1-5	1.55-1.65	>20	0.02-0.06	7.4-8.4	Low----------	0.10			
639----------	0-12	10-18	1.50-1.55	2.0-6.0	0.10-0.12	5.6-7.3	Low----------	0.24	4	3	1-2
Ridgeport	12-27	10-18	1.55-1.60	2.0-6.0	0.07-0.09	5.6-7.3	Low----------	0.24			
	27-60	2-8	1.60-1.75	>20	0.01-0.03	7.4-8.4	Low----------	0.10			
820B*:											
Dickman---------	0-11	6-18	1.30-1.40	2.0-6.0	0.13-0.15	5.6-6.5	Low----------	0.20	3	3	2-4
	11-17	6-18	1.35-1.50	2.0-6.0	0.12-0.14	5.6-7.3	Low----------	0.20			
	17-60	1-10	1.50-1.60	6.0-20	0.02-0.07	6.1-7.8	Low----------	0.15			
Clarion---------	0-13	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.28	5	6	3-5
	13-28	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low----------	0.37			
	28-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37			
919*:											
Lemond----------	0-15	6-18	1.30-1.40	2.0-6.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L	4-8
	15-27	6-18	1.35-1.50	2.0-6.0	0.10-0.13	7.4-8.4	Low----------	0.28			
	27-60	1-10	1.50-1.70	6.0-20	0.05-0.07	7.4-8.4	Low----------	0.15			
Canisteo--------	0-16	22-32	1.25-1.35	0.6-2.0	0.18-0.22	7.4-8.4	Moderate-----	0.24	5	4L	4-8
	16-35	10-35	1.30-1.50	0.6-6.0	0.12-0.18	7.4-8.4	Low----------	0.32			
	35-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low----------	0.32			
920B*, 920C*:											
Clarion---------	0-10	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.28	5	6	3-5
	10-23	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low----------	0.37			
	23-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37			
Estherville-----	0-10	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	Low----------	0.20	3	3	2-4
	10-15	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	Low----------	0.20			
	15-60	0-8	1.50-1.65	6.0-20	0.02-0.04	6.6-8.4	Low----------	0.10			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
920B*, 920C*:											
Storden	0-10	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	4L	1-2
	10-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
921B2*, 921C2*:											
Clarion	0-10	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.28	5	6	3-5
	10-25	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low	0.37			
	25-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Storden	0-10	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	4L	1-2
	10-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
923E*:											
Copaston	0-16	14-20	1.30-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.28	2	5	2-5
	16	---	---	---	---	---	---	---			
Rock outcrop.											
929*:											
Fieldon	0-20	15-22	1.25-1.40	0.6-2.0	0.18-0.20	7.4-8.4	Low	0.28	5	4L	5-8
	20-31	10-18	1.35-1.55	0.6-2.0	0.15-0.17	7.4-8.4	Low	0.20			
	31-60	5-15	1.40-1.60	2.0-6.0	0.05-0.07	7.4-8.4	Low	0.20			
Canisteo	0-17	22-32	1.25-1.35	0.6-2.0	0.18-0.22	7.4-8.4	Moderate	0.24	5	4L	4-8
	17-28	10-35	1.30-1.50	0.6-6.0	0.12-0.18	7.4-8.4	Low	0.32			
	28-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	Low	0.32			
946*:											
Dickman	0-14	6-18	1.30-1.40	2.0-6.0	0.13-0.15	5.6-6.5	Low	0.20	3	3	2-5
	14-18	6-18	1.35-1.50	2.0-6.0	0.10-0.13	5.6-7.3	Low	0.20			
	18-60	1-10	1.50-1.60	6.0-20	0.02-0.07	5.6-7.8	Low	0.15			
Nicollet	0-16	24-35	1.15-1.25	0.6-2.0	0.17-0.22	5.6-7.3	Moderate	0.24	5	6	4-8
	16-29	24-35	1.25-1.35	0.6-2.0	0.15-0.19	5.6-7.8	Moderate	0.32			
	29-60	22-32	1.35-1.55	0.6-2.0	0.14-0.19	7.4-8.4	Low	0.32			
954B2*, 954C2*:											
Ves	0-10	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.3	Low	0.24	5	6	2-6
	10-19	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.1-7.8	Moderate	0.24			
	19-60	20-32	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Storden	0-8	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	4L	1-2
	8-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
954D2*:											
Storden	0-9	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	4L	1-2
	9-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Ves	0-9	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	Low	0.24	5	6	2-6
	9-18	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.1-7.8	Moderate	0.24			
	18-60	20-32	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
960D2*:											
Storden	0-10	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low	0.28	5	4L	1-2
	10-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			
Clarion	0-10	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.28	5	6	3-5
	10-18	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low	0.37			
	18-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low	0.37			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
968*:											
Hanska----------	0-18	6-18	1.30-1.40	2.0-6.0	0.15-0.18	6.1-7.3	Low----------	0.28	4	3	5-8
	18-23	6-18	1.35-1.50	2.0-6.0	0.10-0.13	6.1-7.3	Low----------	0.28			
	23-29	2-10	1.50-1.60	6.0-20	0.08-0.10	6.1-7.8	Low----------	0.17			
	29-60	1-10	1.50-1.60	6.0-20	0.03-0.05	6.6-7.8	Low----------	0.17			
Webster---------	0-16	26-35	1.35-1.40	0.6-2.0	0.19-0.21	6.1-7.3	Moderate-----	0.24	5	6	5-8
	16-26	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	Moderate-----	0.32			
	26-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Moderate-----	0.32			
999B*, 999C*:											
Ves----------	0-10	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	5	6	2-6
	10-26	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.1-7.8	Moderate-----	0.24			
	26-60	20-32	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37			
Storden---------	0-9	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L	1-2
	9-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37			
Estherville-----	0-10	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	Low----------	0.20	3	3	2-4
	10-15	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	Low----------	0.20			
	15-60	0-8	1.50-1.65	6.0-20	0.02-0.04	6.6-8.4	Low----------	0.10			
999D*:											
Storden---------	0-9	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L	1-2
	9-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37			
Ves----------	0-10	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.24	5	6	2-6
	10-19	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.1-7.8	Moderate-----	0.24			
	19-60	20-32	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37			
Hawick----------	0-10	2-10	1.40-1.60	6.0-20	0.10-0.12	6.1-7.8	Low----------	0.17	3	2	1-3
	10-16	1-10	1.50-1.65	>6.0	0.03-0.10	6.1-7.8	Low----------	0.10			
	16-60	1-5	1.55-1.65	>20	0.02-0.06	7.4-8.4	Low----------	0.10			
999F*:											
Storden---------	0-8	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.28	5	4L	1-2
	8-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low----------	0.37			
Hawick----------	0-11	2-10	1.40-1.60	6.0-20	0.10-0.12	6.1-7.8	Low----------	0.17	3	2	1-3
	11-21	1-10	1.50-1.65	>6.0	0.03-0.10	6.1-7.8	Low----------	0.10			
	21-60	1-5	1.55-1.65	>20	0.02-0.06	7.4-8.4	Low----------	0.10			
1016, 1027. Udorthents											
1029*. Pits											
1052*:											
Okoboji----------	0-13	35-45	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	High----------	0.37	5	8	5-10
	13-29	35-45	1.35-1.40	0.2-0.6	0.18-0.20	6.6-7.8	High----------	0.37			
	29-60	35-45	1.35-1.40	0.2-0.6	0.18-0.20	6.6-7.8	High----------	0.37			
Palms-----------	0-23	---	0.25-0.45	0.6-2.0	0.35-0.45	5.1-7.8	----------	----	2	2	>75
	23-60	7-35	1.45-1.75	0.2-0.6	0.14-0.22	6.1-8.4	Low----------	----			
1829B, 1829C----- Ridgeport Variant	0-9	10-25	1.30-1.50	2.0-6.0	0.14-0.20	5.6-7.3	Low----------	0.20	3	3	2-4
	9-16	10-18	1.40-1.60	2.0-6.0	0.10-0.14	6.1-7.3	Low----------	0.20			
	16-25	0-8	1.50-1.70	6.0-20	0.02-0.04	6.1-7.8	Low----------	0.10			
	25-60	---	---	---	---	---	----------	----			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
1833----------	0-10	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High----------	0.28	5	7	5-8
Coland	10-46	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	High----------	0.28			
	46-60	12-26	1.50-1.65	0.6-6.0	0.13-0.17	6.1-7.8	Low-----------	0.28			
1887----------	0-9	27-35	1.40-1.60	0.6-2.0	0.17-0.23	7.4-8.4	Moderate------	0.28	5	6	5-8
Millington	9-41	18-35	1.40-1.60	0.6-2.0	0.17-0.20	7.4-8.4	Moderate------	0.28			
	41-60	2-8	1.60-1.75	>20	0.03-0.06	7.4-8.4	Low-----------	0.10			
1909----------	0-30	6-18	1.30-1.40	2.0-6.0	0.20-0.22	7.4-8.4	Low-----------	0.28	5	4L	>18
Lemond	30-36	6-18	1.35-1.60	2.0-6.0	0.10-0.13	7.4-8.4	Low-----------	0.28			
	36-60	1-10	1.50-1.70	6.0-20	0.05-0.07	7.4-8.4	Low-----------	0.15			
1911F*:											
Storden---------	0-6	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	Low-----------	0.28	5	4L	1-2
	6-60	18-30	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37			
Ridgeport Variant--------	0-14	10-25	1.30-1.50	2.0-6.0	0.14-0.20	5.6-7.3	Low-----------	0.20	3	3	2-4
	14-60	---	---	---	---	---	----------	----			
1912----------	0-20	26-35	1.35-1.40	0.6-2.0	0.19-0.21	7.4-8.4	Moderate------	0.24	5	6	5-8
Tilfer Variant	20-32	20-32	1.40-1.50	0.6-2.0	0.17-0.19	7.4-8.4	Moderate------	0.32			
	32-60	---	---	---	---	---	----------	----			
1917----------	0-26	36-44	1.30-1.35	0.06-0.2	0.12-0.14	7.4-8.4	High----------	0.37	5	4	6-10
Nishna	26-60	38-46	1.35-1.40	0.06-0.2	0.11-0.13	7.4-8.4	High----------	0.28			
1919F*:											
Clarion---------	0-15	18-24	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low-----------	0.28	5	6	3-5
	15-37	24-30	1.50-1.70	0.6-2.0	0.17-0.19	5.6-7.8	Low-----------	0.37			
	37-60	12-22	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	Low-----------	0.37			
Terril----------	0-31	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low-----------	0.24	5	6	4-5
	31-60	22-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	Low-----------	0.32			
1928----------	0-18	6-18	1.30-1.40	2.0-6.0	0.20-0.22	6.1-7.3	Low-----------	0.28	4	5	4-8
Hanska	18-26	6-18	1.35-1.50	2.0-6.0	0.10-0.13	6.1-7.3	Low-----------	0.28			
	26-31	2-10	1.50-1.60	6.0-20	0.08-0.10	6.1-7.8	Low-----------	0.17			
	31-60	1-10	1.50-1.60	6.0-20	0.03-0.05	6.6-7.8	Low-----------	0.17			
1929----------	0-18	6-18	1.30-1.40	2.0-6.0	0.20-0.22	7.4-8.4	Low-----------	0.28	5	4L	4-8
Lemond	18-27	6-18	1.35-1.50	2.0-6.0	0.10-0.13	7.4-8.4	Low-----------	0.28			
	27-60	1-10	1.50-1.70	6.0-20	0.05-0.07	7.4-8.4	Low-----------	0.15			
1930----------	0-15	6-18	1.30-1.40	2.0-6.0	0.13-0.15	5.6-6.5	Low-----------	0.20	3	3	2-5
Dickman	15-24	6-18	1.35-1.50	2.0-6.0	0.10-0.13	5.6-7.3	Low-----------	0.20			
	24-60	1-10	1.50-1.60	6.0-20	0.02-0.07	5.6-7.8	Low-----------	0.15			
1931----------	0-9	12-18	1.30-1.50	2.0-6.0	0.13-0.18	7.4-8.4	Low-----------	0.24	5	3	4-8
Essexville	9-23	2-12	1.40-1.55	6.0-20	0.04-0.12	7.4-8.4	Low-----------	0.17			
	23-60	10-35	1.45-1.70	0.2-0.6	0.12-0.20	7.4-8.4	Moderate------	0.32			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "rare," "brief," and "apparent" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness			Uncoated steel	Concrete
					Ft			In		In			
8B, 8C---------- Sparta	A	None--------	---	---	>6.0	---	---	>60	---	---	Low------	Low------	Moderate.
27A, 27B-------- Dickinson	B	None--------	---	---	>6.0	---	---	>60	---	---	Moderate	Low------	Moderate.
31E, 31F-------- Storden	B	None--------	---	---	>6.0	---	---	>60	---	---	Moderate	Low------	Low.
35---------- Blue Earth	B/D	None--------	---	---	+2-1.0	Apparent	Jan-Dec	>60	---	---	High-----	High-----	Low.
41A, 41B-------- Estherville	B	None--------	---	---	>6.0	---	---	>60	---	---	Low------	Low------	Low.
85---------- Calco	B/D	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	---	High-----	High-----	Low.
86---------- Canisteo	B/D	None--------	---	---	1.0-3.0	Apparent	Oct-Jul	>60	---	---	High-----	High-----	Low.
94B, 94C-------- Terril	B	None--------	---	---	>6.0	---	---	>60	---	---	Moderate	Moderate	Low.
102B, 102B2----- Clarion	B	None--------	---	---	>6.0	---	---	>60	---	---	Moderate	Low------	Low.
113---------- Webster	B/D	None--------	---	---	1.0-2.0	Apparent	Nov-Jul	>60	---	---	High-----	High-----	Low.
114---------- Glencoe	B/D	None--------	---	---	+1-1.0	Apparent	Oct-Jun	>60	---	---	High-----	High-----	Low.
128B---------- Grogan	B	None--------	---	---	>6.0	---	---	>60	---	---	High-----	Low------	Low.
130---------- Nicollet	B	None--------	---	---	2.5-5.0	Apparent	Mar-Jun	>60	---	---	High-----	High-----	Low.
134---------- Okoboji	B/D	None--------	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	---	High-----	High-----	Low.
136---------- Madelia	B/D	None--------	---	---	1.0-2.5	Apparent	Nov-May	>60	---	---	High-----	High-----	Low.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness			Uncoated steel	Concrete
					Ft			In		In			
140--Spicer	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	>60	---	---	High	High	Low.
227--Lemond	B/D	None	---	---	1.0-3.0	Apparent	Nov-May	>60	---	---	High	High	Low.
247--Linder	B	None	---	---	2.5-5.0	Apparent	Nov-Jul	>60	---	---	High	Moderate	Low.
269--Millington	B/D	Occasional	Brief	Apr-Jun	1.0-2.0	Apparent	Mar-Jul	>60	---	---	High	High	Low.
281--Darfur	B/D	None	---	---	1.0-3.0	Apparent	Dec-May	>60	---	---	High	High	Low.
282--Hanska	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	>60	---	---	High	High	Low.
313--Spillville	B	Occasional	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	>60	---	---	Moderate	High	Moderate.
317--Oshawa	C/D	Frequent	Long	Apr-Jul	+1-1.0	Apparent	Apr-Jul	>60	---	---	High	High	Low.
327A, 327B--Dickman	A	None	---	---	>6.0	---	---	>60	---	---	Low	Low	Moderate.
336--Delft	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	>60	---	---	High	High	Low.
386--Okoboji	B/D	None	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	5-10	High	High	Low.
421B, 421B2--Ves	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Moderate	Low.
423--Seaforth	B	None	---	---	3.0-6.0	Apparent	Mar-Jun	>60	---	---	High	High	Low.
446--Normania	B	None	---	---	2.5-6.0	Apparent	Mar-Jun	>60	---	---	High	High	Low.
463--Minneiska	B	Occasional	Brief	Mar-Jul	3.0-6.0	Apparent	Mar-Jun	>60	---	---	Moderate	Low	Low.
487--Hoopeston	B	None	---	---	2.5-5.0	Apparent	Mar-Jun	>60	---	---	High	Low	Moderate.
495--Zumbro	A	Rare	---	---	>6.0	---	---	>60	---	---	Low	Low	Low.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness			Uncoated steel	Concrete
					Ft			In		In			
499---------- Hanska	B/D	None--------	---	---	+1-2.5	Apparent	Nov-Jun	>60	---	---	High-----	High-----	Low.
518---------- Kalmarville	B/D	Occasional	Brief-----	Mar-Jun	0-1.0	Apparent	Nov-Aug	>60	---	---	High-----	Moderate	Low.
539---------- Palms	A/D	None--------	---	---	+1-1.0	Apparent	Nov-May	>60	---	10-20	High-----	High-----	Moderate.
574---------- Du Page	B	Occasional	Brief-----	Apr-Jun	4.0-6.0	Apparent	Feb-Jun	>60	---	---	Moderate	Low------	Low.
575---------- Nishna	C/D	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	---	Moderate	High-----	Low.
603---------- Hanlon	B	Occasional	Very brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jun	>60	---	---	Moderate	Moderate	Low.
611B, 611C------ Hawick	A	None--------	---	---	>6.0	---	---	>60	---	---	Low------	Low------	Low.
639---------- Ridgeport	B	None--------	---	---	>6.0	---	---	>60	---	---	Low------	Low------	Low.
820B*:													
Dickman--------	A	None--------	---	---	>6.0	---	---	>60	---	---	Low------	Low------	Moderate.
Clarion--------	B	None--------	---	---	>6.0	---	---	>60	---	---	Moderate	Low------	Low.
919*:													
Lemond---------	B/D	None--------	---	---	1.0-3.0	Apparent	Nov-May	>60	---	---	High-----	High-----	Low.
Canisteo-------	B/D	None--------	---	---	1.0-3.0	Apparent	Oct-Jul	>60	---	---	High-----	High-----	Low.
920B*, 920C*:													
Clarion--------	B	None--------	---	---	>6.0	---	---	>60	---	---	Moderate	Low------	Low.
Estherville----	B	None--------	---	---	>6.0	---	---	>60	---	---	Low------	Low------	Low.
Storden--------	B	None--------	---	---	>6.0	---	---	>60	---	---	Moderate	Low------	Low.
921B2*, 921C2*:													
Clarion--------	B	None--------	---	---	>6.0	---	---	>60	---	---	Moderate	Low------	Low.
Storden--------	B	None--------	---	---	>6.0	---	---	>60	---	---	Moderate	Low------	Low.
923E*:													
Copaston-------	D	None--------	---	---	>6.0	---	---	12-20	Hard	---	Moderate	Low------	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness			Uncoated steel	Concrete
					Ft			In		In			
923E*: Rock outcrop.													
929*: Fieldon	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	>60	---	---	High	High	Low.
Canisteo	B/D	None	---	---	1.0-3.0	Apparent	Oct-Jul	>60	---	---	High	High	Low.
946*: Dickman	A	None	---	---	3.0-6.0	Apparent	Nov-Jun	>60	---	---	Low	Low	Moderate.
Nicollet	B	None	---	---	2.5-5.0	Apparent	Mar-Jun	>60	---	---	High	High	Low.
954B2*, 954C2*: Ves	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Moderate	Low.
Storden	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Low	Low.
954D2*: Storden	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Low	Low.
Ves	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Moderate	Low.
960D2*: Storden	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Low	Low.
Clarion	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Low	Low.
968*: Hanska	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	>60	---	---	High	High	Low.
Webster	B/D	None	---	---	1.0-2.0	Apparent	Nov-Jul	>60	---	---	High	High	Low.
999B*, 999C*: Ves	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Moderate	Low.
Storden	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Low	Low.
Estherville	B	None	---	---	>6.0	---	---	>60	---	---	Low	Low	Low.
999D*: Storden	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Low	Low.
Ves	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Moderate	Low.
Hawick	A	None	---	---	>6.0	---	---	>60	---	---	Low	Low	Low.
999F*: Storden	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Low	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness			Uncoated steel	Concrete
					Ft			In		In			
999F*: Hawick	A	None	---	---	>6.0	---	---	>60	---	---	Low	Low	Low.
1016, 1027. Udorthents													
1029*. Pits													
1052*: Okoboji	D	None	---	---	+3-1.0	Apparent	Jan-Dec	>60	---	---	High	High	Low.
Palms	A/D	None	---	---	+1-1.0	Apparent	Nov-May	>60	---	10-20	High	High	Moderate.
1829B, 1829C---- Ridgeport Variant	B	None	---	---	>6.0	---	---	20-40	Soft	---	Low	Low	Low.
1833---------- Coland	B/D	Occasional	Brief	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	---	High	High	Low.
1887---------- Millington	B/D	Occasional	Brief	Apr-Jun	1.0-2.0	Apparent	Mar-Jul	>60	---	---	High	High	Low.
1909---------- Lemond	B/D	None	---	---	+1-2.5	Apparent	Nov-Jun	>60	---	---	High	High	Low.
1911F*: Storden	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Low	Low.
Ridgeport Variant	B	None	---	---	>6.0	---	---	20-40	Soft	---	Low	Low	Low.
1912---------- Tilfer Variant	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	20-40	Soft	---	High	High	Low.
1917---------- Nishna	D	Frequent	Long	Mar-Nov	+1-1.0	Apparent	Jan-Dec	>60	---	---	Moderate	High	Low.
1919F*: Clarion	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Low	Low.
Terril	B	None	---	---	>6.0	---	---	>60	---	---	Moderate	Moderate	Low.
1928---------- Hanska	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	>60	---	---	High	High	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Total subsidence	Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness			Uncoated steel	Concrete
					Ft			In		In			
1929--Lemond	B/D	None	---	---	1.0-3.0	Apparent	Nov-Jun	>60	---	---	High	High	Low.
1930--Dickman	A	None	---	---	3.0-6.0	Apparent	Nov-Jun	>60	---	---	Low	Low	Moderate.
1931--Essexville	A/D	None	---	---	0-1.0	Apparent	Nov-May	>60	---	---	High	High	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Blue Earth	Fine-silty, mixed (calcareous), mesic Mollic Fluvaquents
Calco	Fine-silty, mixed (calcareous), mesic Cumulic Haplaquolls
Canisteo	Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls
Clarion	Fine-loamy, mixed, mesic Typic Hapludolls
Coland	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Copaston	Loamy, mixed, mesic Lithic Hapludolls
Darfur	Coarse-loamy, mixed, mesic Typic Haplaquolls
Delft	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Dickinson	Coarse-loamy, mixed, mesic Typic Hapludolls
Dickman	Sandy, mixed, mesic Typic Hapludolls
Du Page	Fine-loamy, mixed, mesic Cumulic Hapludolls
Essexville	Sandy over loamy, mixed (calcareous), mesic Typic Haplaquolls
Estherville	Sandy, mixed, mesic Typic Hapludolls
Fieldon	Coarse-loamy, mixed (calcareous), mesic Typic Haplaquolls
Glencoe	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Grogan	Coarse-silty, mixed, mesic Typic Hapludolls
Hanlon	Coarse-loamy, mixed, mesic Cumulic Hapludolls
Hanska	Coarse-loamy, mixed, mesic Typic Haplaquolls
Hawick	Sandy, mixed, mesic Entic Hapludolls
*Hoopeston	Coarse-loamy, mixed, mesic Aquic Hapludolls
*Kalmarville	Coarse-loamy, mixed, nonacid, mesic Mollic Fluvaquents
Lemond	Coarse-loamy, mixed (calcareous), mesic Typic Haplaquolls
*Linder	Coarse-loamy, mixed, mesic Aquic Hapludolls
Madelia	Fine-silty, mixed, mesic Typic Haplaquolls
Millington	Fine-loamy, mixed (calcareous), mesic Cumulic Haplaquolls
Minneiska	Coarse-loamy, mixed (calcareous), mesic Mollic Udifluvents
Nicollet	Fine-loamy, mixed, mesic Aquic Hapludolls
Nishna	Fine, montmorillonitic (calcareous), mesic Cumulic Haplaquolls
Normania	Fine-loamy, mixed, mesic Aquic Haplustolls
Okoboji	Fine, montmorillonitic, mesic Cumulic Haplaquolls
Oshawa	Fine-loamy, mixed (calcareous), mesic Cumulic Haplaquolls
Palms	Loamy, mixed, euic, mesic Terric Medisaprists
Ridgeport	Coarse-loamy, mixed, mesic Typic Hapludolls
Ridgeport Variant	Coarse-loamy, mixed, mesic Typic Hapludolls
Seaforth	Fine-loamy, mixed, mesic Aquic Calciustolls
*Sparta	Sandy, mixed, mesic Entic Hapludolls
Spicer	Fine-silty, mixed (calcareous), mesic Typic Haplaquolls
Spillville	Fine-loamy, mixed, mesic Cumulic Hapludolls
Storden	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Terril	Fine-loamy, mixed, mesic Cumulic Hapludolls
Tilfer Variant	Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls
Udorthents, loamy	Loamy, mixed, mesic Typic Udorthents
Udorthents, wet substratum	Loamy, mixed, mesic Aquic Udorthents
Ves	Fine-loamy, mixed, mesic Udic Haplustolls
Webster	Fine-loamy, mixed, mesic Typic Haplaquolls
Zumbro	Sandy, mixed, mesic Entic Hapludolls

☆ U.S. GOVERNMENT PRINTING OFFICE : 1988 O - 183-503 : QL 3

Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at 1-800-457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410, or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
MINNESOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP
BROWN COUNTY, MINNESOTA

Scale 1:190,080

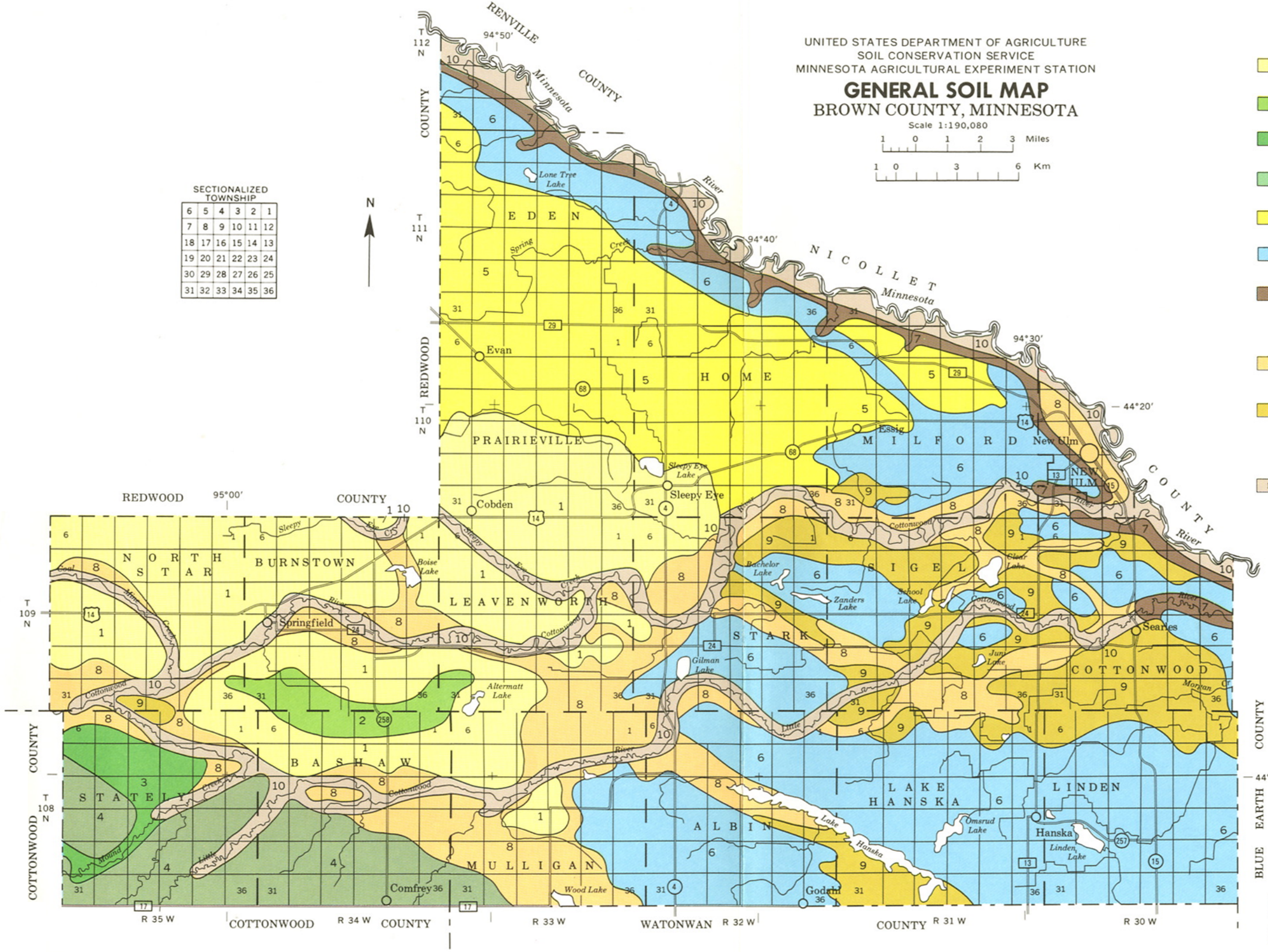
1 0 1 2 3 Miles

1 0 3 6 Km

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

N



LEGEND*

NEARLY LEVEL TO VERY STEEP, LOAMY AND SILTY SOILS ON UPLANDS

1 Canisteo-Ves-Seaforth association: Nearly level to moderately steep, poorly drained, well drained, and moderately well drained, loamy soils on ground moraines

2 Canisteo-Glencoe-Seaforth association: Nearly level, poorly drained, very poorly drained, and moderately well drained, loamy and silty soils on ground moraines

3 Ves-Webster-Storden association: Nearly level to very steep, well drained and poorly drained, loamy soils on ground moraines and till plains

4 Normania-Webster-Ves association: Nearly level to moderately steep, moderately well drained, poorly drained, and well drained, loamy soils on ground moraines and till plains

5 Webster-Nicollet-Okoboji association: Nearly level, poorly drained, moderately well drained, and very poorly drained, loamy and silty soils on till plains and ground moraines

6 Webster-Nicollet-Clarion association: Nearly level to moderately steep, poorly drained, moderately well drained, and well drained, loamy soils on till plains and ground moraines

7 Clarion-Storden-Terril association: Very steep, well drained and moderately well drained, loamy soils on till plains, ground moraines, and foot slopes

NEARLY LEVEL AND GENTLY SLOPING, LOAMY SOILS MAINLY ON VALLEY TRAINS

8 Dickman-Estherville-Lemond association: Nearly level and gently sloping, well drained, moderately well drained, poorly drained and very poorly drained, loamy soils on valley trains and outwash plains

9 Lemond-Nicollet-Dickman association: Nearly level and gently sloping, very poorly drained, poorly drained, moderately well drained, and well drained, loamy soils on valley trains, ground moraines, and outwash plains

NEARLY LEVEL, LOAMY AND SILTY SOILS ON FLOOD PLAINS

10 Millington-Minneiska-Calco association: Nearly level, poorly drained and moderately well drained, loamy and silty soils on flood plains

*Texture terms in the descriptive headings refer to the surface layer of the major soils in the associations.

COMPILED 1986

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

INDEX TO MAP SHEETS
BROWN COUNTY, MINNESOTA

Scale 1:190,080

1 0 1 2 3 Miles

1 0 3 6 Km

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

N

RENVILLE COUNTY

Minnesota River

Lone Tree Lake

Spring Creek

Inset, sheet 5

Inset, sheet 1

Inset sheet 37

Inset sheet 37

Inset sheet 37

REDWOOD COUNTY

COTTONWOOD COUNTY

BLUE EARTH COUNTY

T 112 N

T 111 N

T 110 N

T 109 N

T 108 N

94°50′

94°40′

94°30′

95°00′

44°20′

44°10′

R 35 W

R 34 W

R 33 W

R 32 W

R 31 W

R 30 W

EDEN

NICOLLET

PRAIRIEVILLE

HOME

MILFORD

NORTH STAR

BURNSTOWN

LEAVENWORTH

STARK

SIGEL

COTTONWOOD

STATELY

BASHAW

LAKE HANSKA

LINDEN

ALBIN

MULLIGAN

WATONWAN COUNTY

Evan

Essig

New Ulm

NEW ULM

Cobden

Sleepy Eye

Springfield

Searles

Comfrey

Godahl

Hanska

Sleepy Eye Lake

Bachelor Lake

Zanders Lake

School Lake

Clear Lake

Juni Lake

Gilman Lake

Altermatt Lake

Omsrud Lake

Linden Lake

Wood Lake

Boise Lake

Coal Mine Creek

Sleepy Eye Cr

Cottonwood River

Little Cottonwood River

Morgan Cr

Little Hanska Lake

Mound Creek

31 6 1 36

1 2 3 4 5 6 7 8 9 10 11 12

13 14 15 16 17 18

19 20 21 22 23 24

25 26 27 28 29 30

31 32 33 34 35 36

37

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and a letter. The initial numbers represent the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas. A final number of 2 following the slope letter indicates that the soil is eroded.

SYMBOL	NAME
8B	Sparta loamy sand, 2 to 6 percent slopes
8C	Sparta loamy sand, 6 to 15 percent slopes
27A	Dickinson sandy loam, 0 to 2 percent slopes
27B	Dickinson sandy loam, 2 to 6 percent slopes
31E	Storden loam, 18 to 24 percent slopes
31F	Storden loam, 24 to 60 percent slopes
35	Blue Earth mucky silt loam
41A	Estherville sandy loam, 0 to 2 percent slopes
41B	Estherville sandy loam, 2 to 6 percent slopes
85	Calco silty clay loam
86	Canisteo clay loam
94B	Terril loam, 2 to 6 percent slopes
94C	Terril loam, 6 to 12 percent slopes
102B	Clarion loam, 1 to 4 percent slopes
102B2	Clarion loam, 3 to 6 percent slopes, eroded
113	Webster clay loam
114	Glencoe clay loam
128B	Grogan silt loam, 1 to 6 percent slopes
130	Nicollet clay loam
134	Okoboji silty clay loam
136	Madelia silty clay loam
140	Spicer silty clay loam
227	Lemond loam
247	Linder sandy loam
269	Millington clay loam
281	Darfur loam
282	Hanska sandy loam
313	Spillville loam
317	Oshawa silty clay loam
327A	Dickman sandy loam, 0 to 2 percent slopes
327B	Dickman sandy loam, 2 to 6 percent slopes
336	Delft clay loam
386	Okoboji muck
421B	Ves loam, 1 to 4 percent slopes
421B2	Ves loam, 3 to 6 percent slopes, eroded
423	Seaforth loam
446	Normania loam
463	Minneiska sandy loam
487	Hoopeston sandy loam
495	Zumbro loamy sand
499	Hanska loam, depressional
518	Kalmarville sandy loam

SYMBOL	NAME
539	Palms muck
574	Du Page loam
575	Nishna silty clay
603	Hanlon sandy loam
611B	Hawick coarse sandy loam, 2 to 6 percent slopes
611C	Hawick coarse sandy loam, 6 to 15 percent slopes
639	Ridgeport sandy loam
820B	Dickman-Clarion complex, 2 to 6 percent slopes
919	Lemond-Canisteo complex
920B	Clarion-Estherville-Storden complex, 2 to 6 percent slopes
920C	Clarion-Estherville-Storden complex, 6 to 12 percent slopes
921B2	Clarion-Storden loams, 3 to 6 percent slopes, eroded
921C2	Clarion-Storden loams, 6 to 12 percent slopes, eroded
923E	Copaston-Rock outcrop complex, 0 to 40 percent slopes
929	Fieldon-Canisteo complex
946	Dickman-Nicollet complex
954B2	Ves-Storden loams, 2 to 6 percent slopes, eroded
954C2	Ves-Storden loams, 6 to 12 percent slopes, eroded
954D2	Storden-Ves loams, 12 to 18 percent slopes, eroded
960D2	Storden-Clarion loams, 12 to 18 percent slopes, eroded
968	Hanska-Webster complex
999B	Ves-Storden-Estherville complex, 2 to 6 percent slopes
999C	Ves-Storden-Estherville complex, 6 to 12 percent slopes
999D	Storden-Ves-Hawick complex, 12 to 18 percent slopes
999F	Storden-Hawick complex, 18 to 50 percent slopes
1016	Udorthents, loamy
1027	Udorthents, wet substratum
1029	Pits, gravel
1052	Okoboji and Palms soils, ponded
1829B	Ridgeport Variant loam, 0 to 6 percent slopes
1829C	Ridgeport Variant loam, 6 to 15 percent slopes
1833	Coland loam
1887	Millington clay loam, sandy substratum
1909	Lemond loam, depressional
1911F	Storden-Ridgeport Variant loams, 15 to 50 percent slopes
1912	Tilfer Variant clay loam
1917	Nishna silty clay, ponded
1919F	Clarion-Terril loams, 25 to 50 percent slopes
1928	Hanska loam, gravelly substratum
1929	Lemond loam, gravelly substratum
1930	Dickman sandy loam, moderately wet
1931	Essexville sandy loam

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

County or parish

Reservation (national forest or park, state forest or park, and large airport)

Field sheet matchline & neatline

AD HOC BOUNDARY (label)

Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK — 500 000 FEET

LAND DIVISION CORNERS (sections and land grants)

ROAD EMBLEMS & DESIGNATIONS

Federal — 71

State — 23

RAILROAD

LEVEES

Without road

DAMS

Medium or small

PITS

Gravel pit

WATER FEATURES

DRAINAGE

Perennial, double line

Perennial, single line

Intermittent

Drainage end

Canals or ditches

Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

Perennial — water

MISCELLANEOUS WATER FEATURES

Marsh or swamp

Spring

Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — 130 / 102B2

ESCARPMENTS

Other than bedrock (points down slope)

SHORT STEEP SLOPE

DEPRESSION OR SINK

MISCELLANEOUS

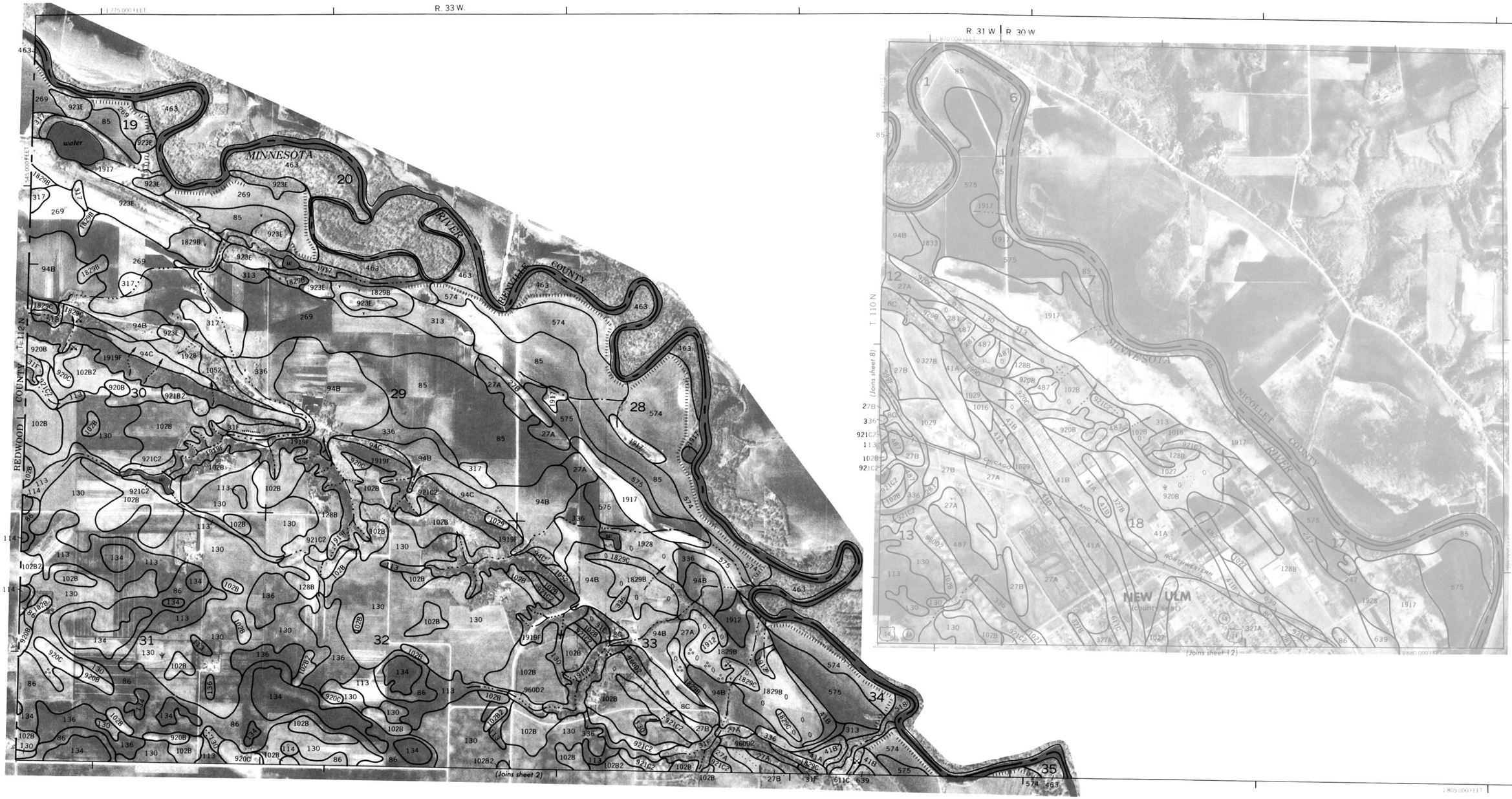
Gravelly spot

Rock outcrop (includes sandstone and shale)

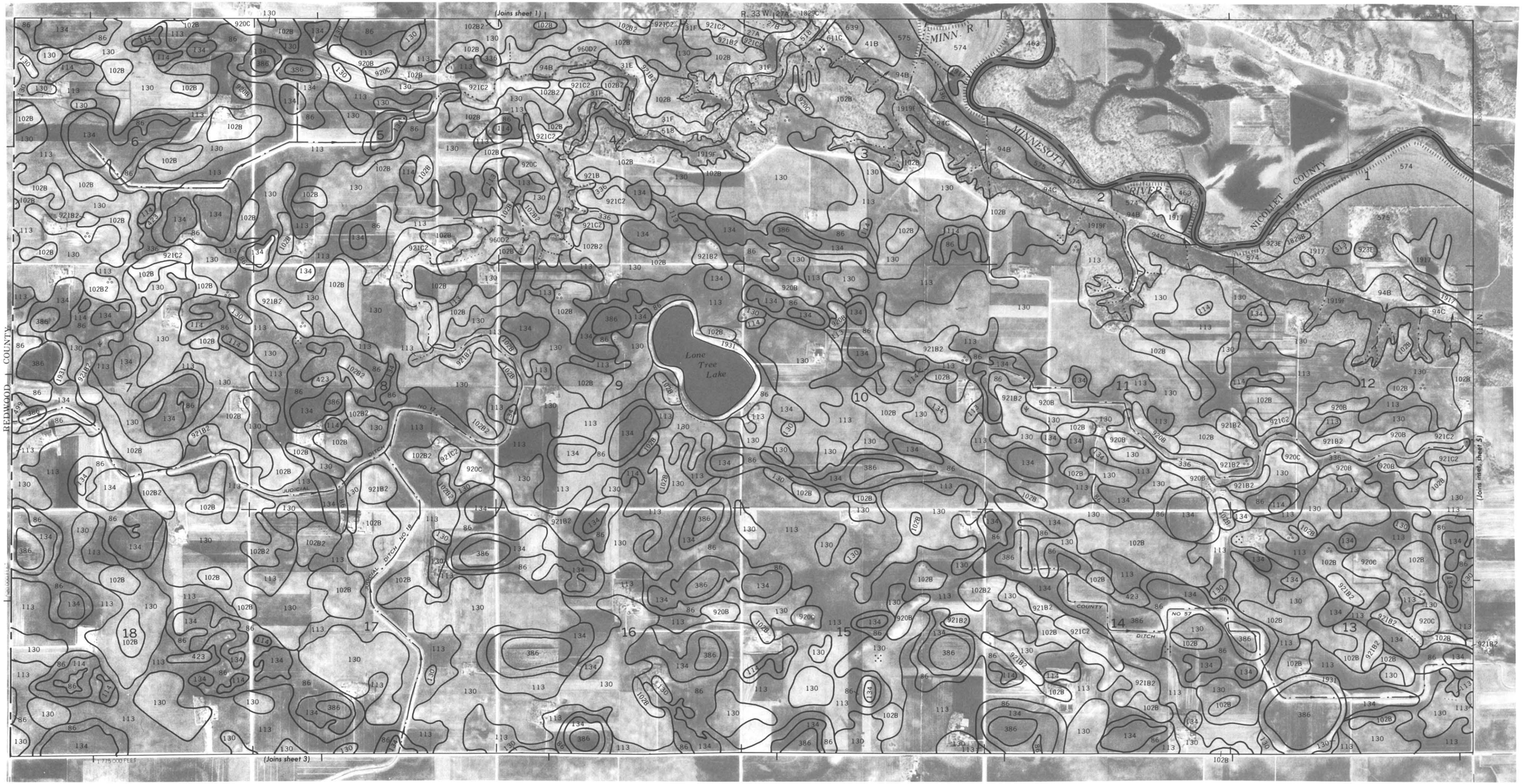
Sandy spot

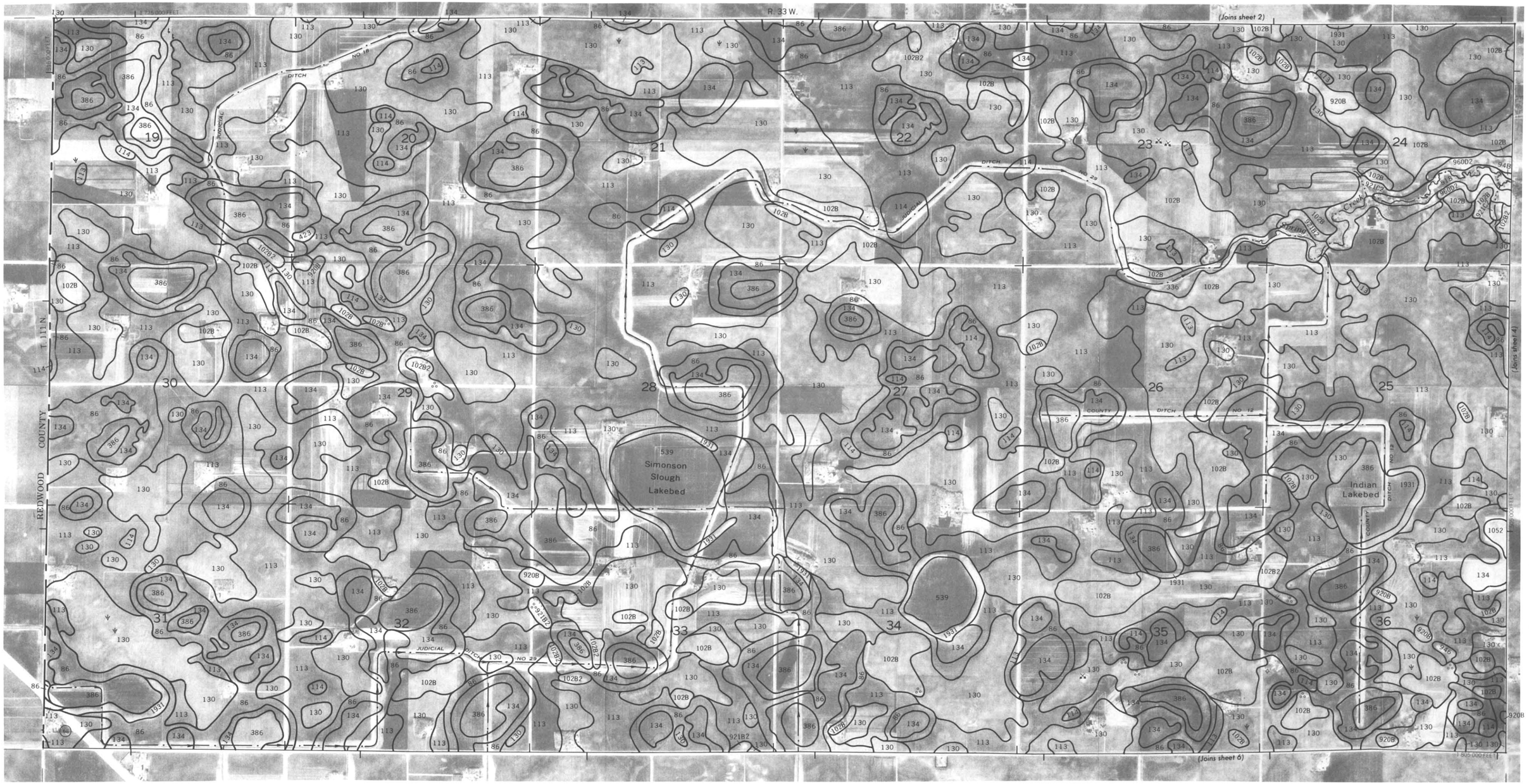
Stony spot, very stony spot

BROWN COUNTY, MINNESOTA — SHEET NUMBER 1

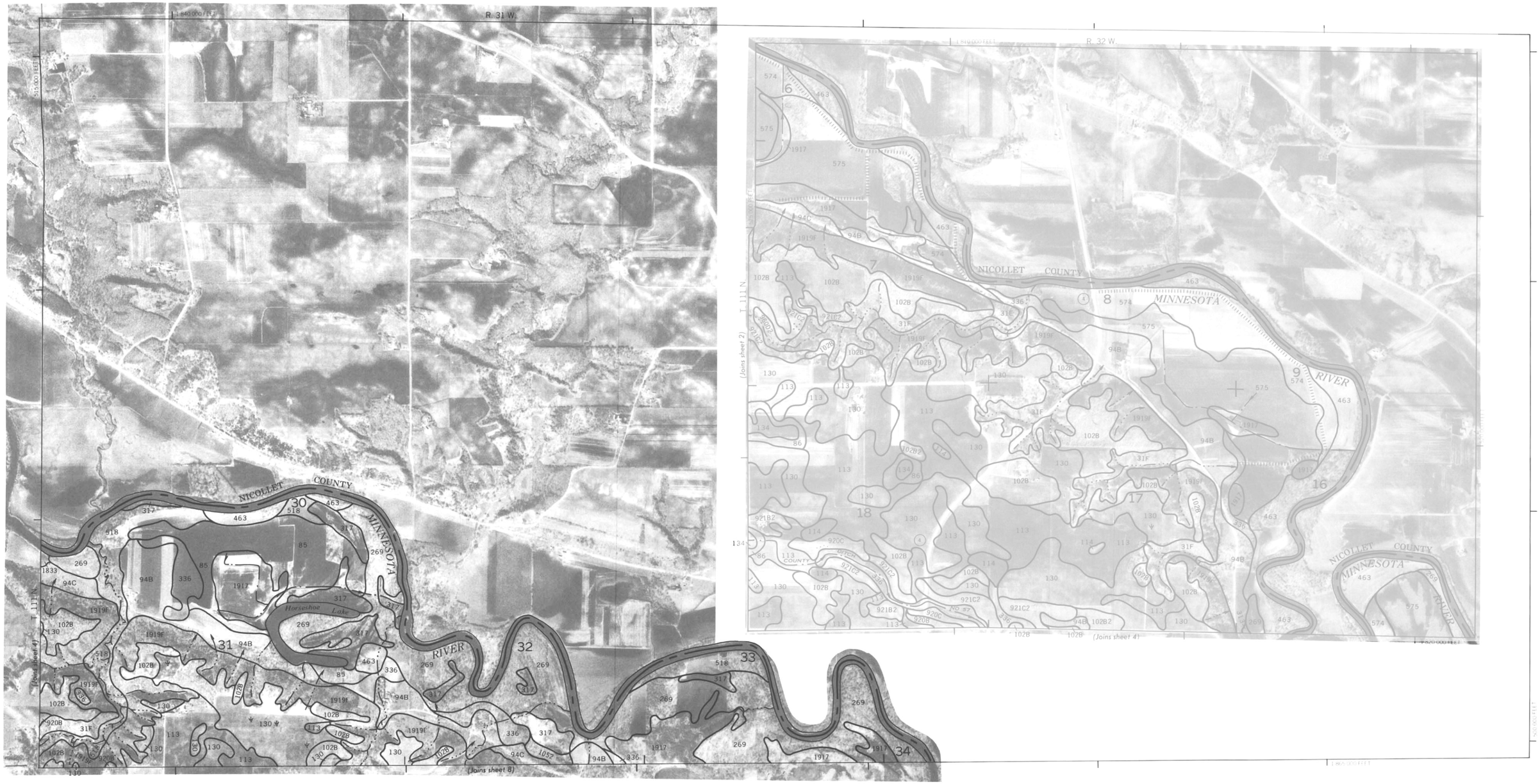


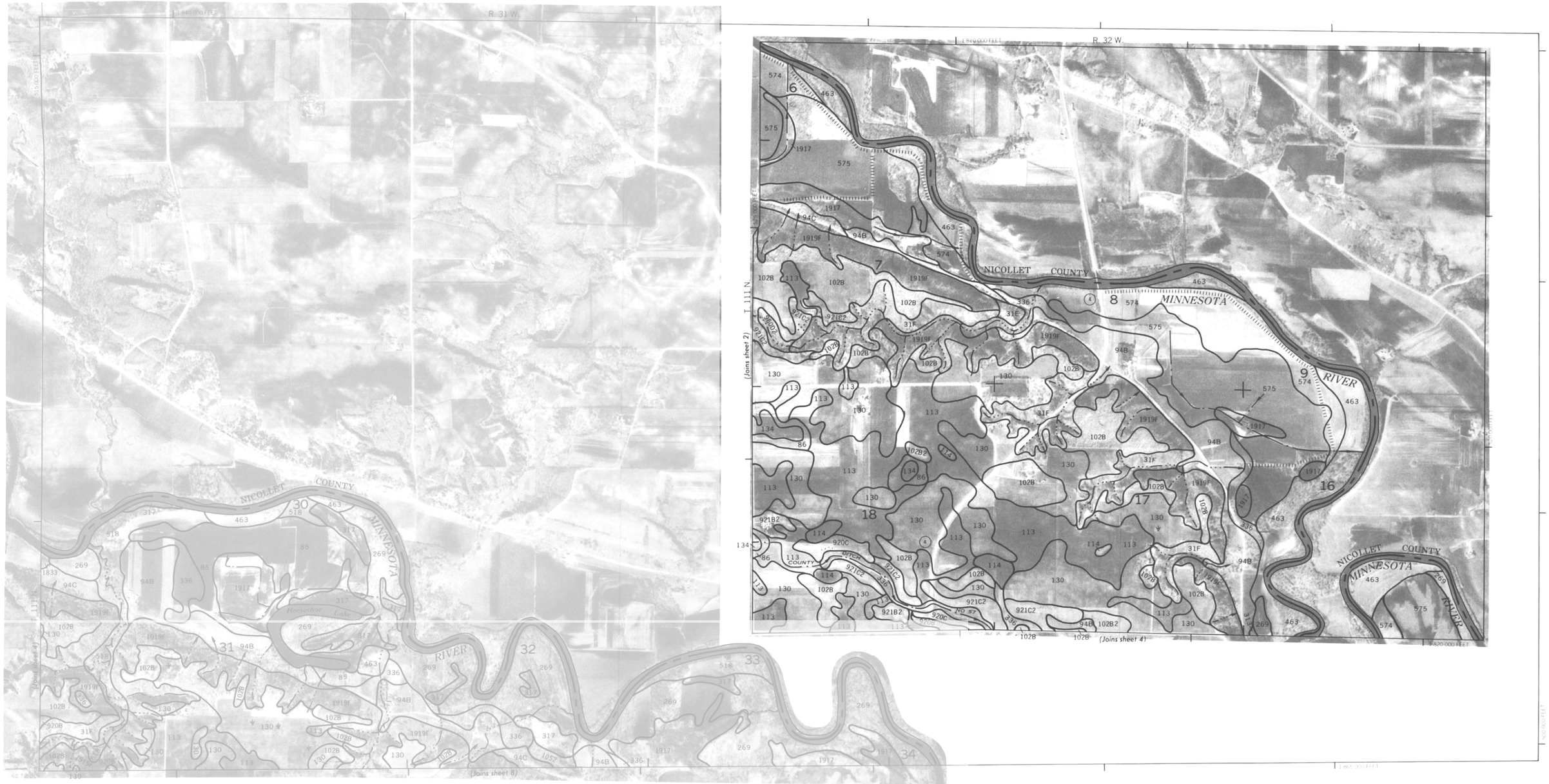

R. 31 W.
R. 30 W.
T. 110 N.
(Joins sheet 8)
(Joins sheet 12)
MINNESOTA
NICOLLET COUNTY
RIVER
CHICAGO AND NORTHWESTERN
NEW ULM
(county seat)
1
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5

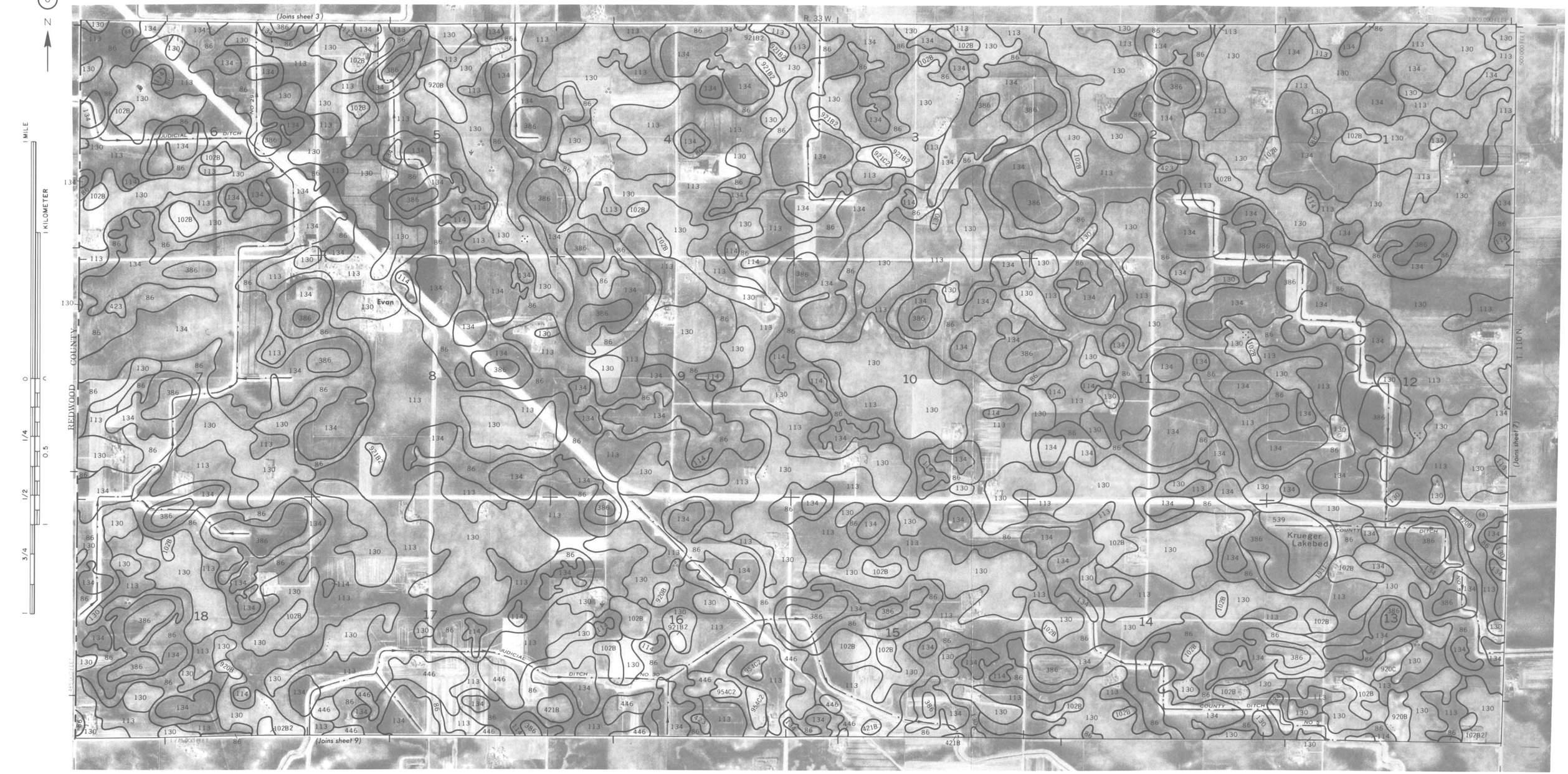

(Joins sheet 1)
R. 33 W.
MINN. R.
MINNESOTA RIVER
NICOLLET COUNTY
REDWOOD COUNTY
Lone Tree Lake
JUDICIAL DITCH NO. 17
JUDICIAL DITCH NO. 18
COUNTY DITCH NO. 57
(Joins sheet 3)
(Joins inset, sheet 5)
1775000 FEET
N
1 MILE
1 KILOMETER


R. 33 W.
T. 111 N.
REDWOOD COUNTY
(Joins sheet 2)
(Joins sheet 4)
(Joins sheet 6)
Simonson Slough Lakebed
Indian Lakebed
JUDICIAL DITCH NO. 29
COUNTY DITCH NO. 12
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
N
1 MILE
1 KILOMETER

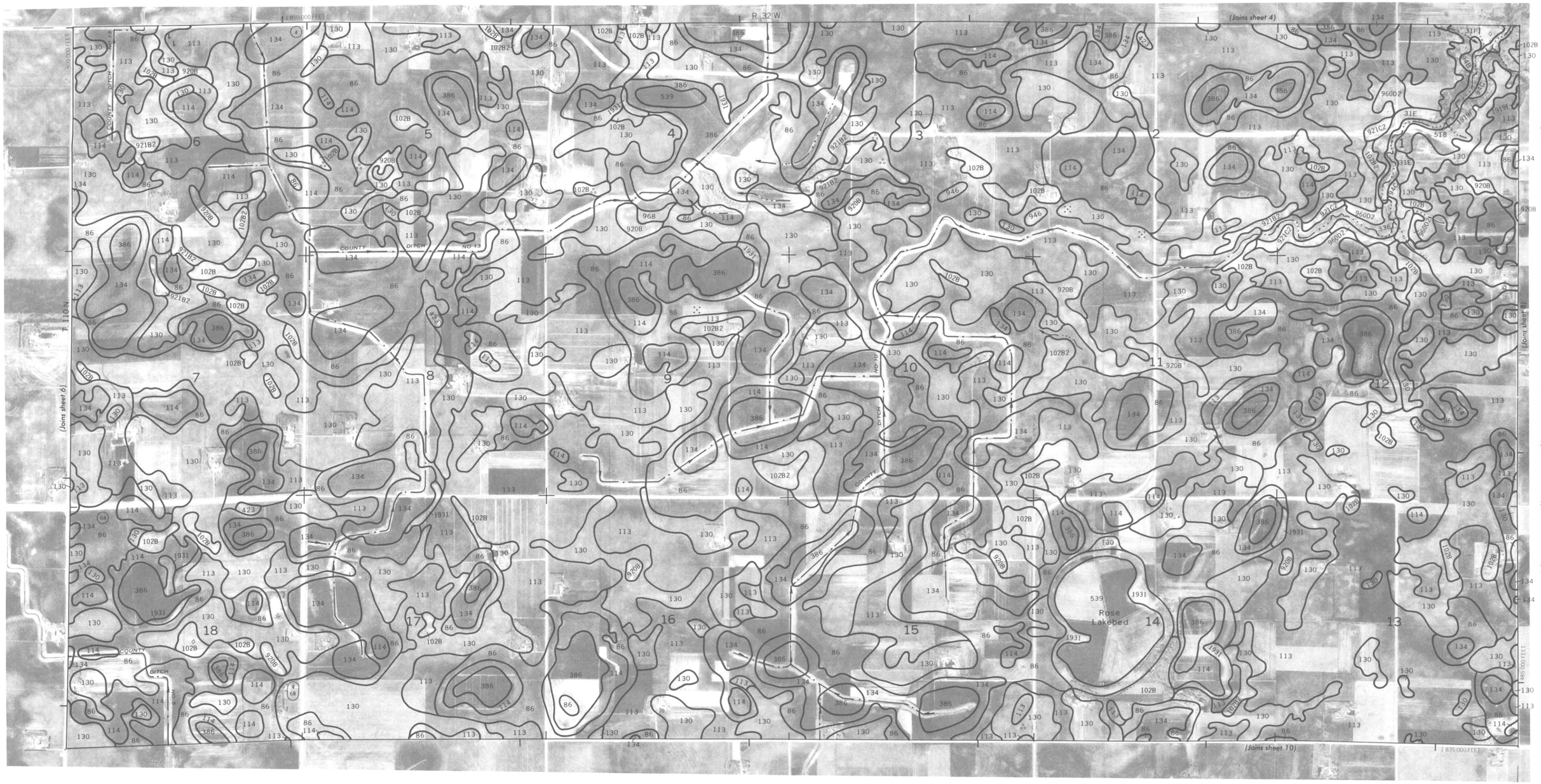

4
N
1 MILE
1 KILOMETER
0
0.5
1/4
1/2
3/4
R. 32 W.
T. 111 N.
MINNESOTA RIVER
NICOLLET COUNTY
Spring Creek
COUNTY DITCH NO 13
(Joins inset, sheet 5)
(Joins sheet 3)
(Joins sheet 5)
(Joins sheet 7)
1 810 000 FEET
615 000 FEET


1 840 000 FEET
R. 31 W.
515 000 FEET
NICOLLET COUNTY
MINNESOTA
RIVER
Horseshoe Lake
T. 111 N.
(Joins sheet 4)
(Joins sheet 8)
R. 32 W.
(Joins sheet 2)
(Joins sheet 4)
5
N
MILE
KILOMETER
0
0
1/4
0.5
1/2
3/4

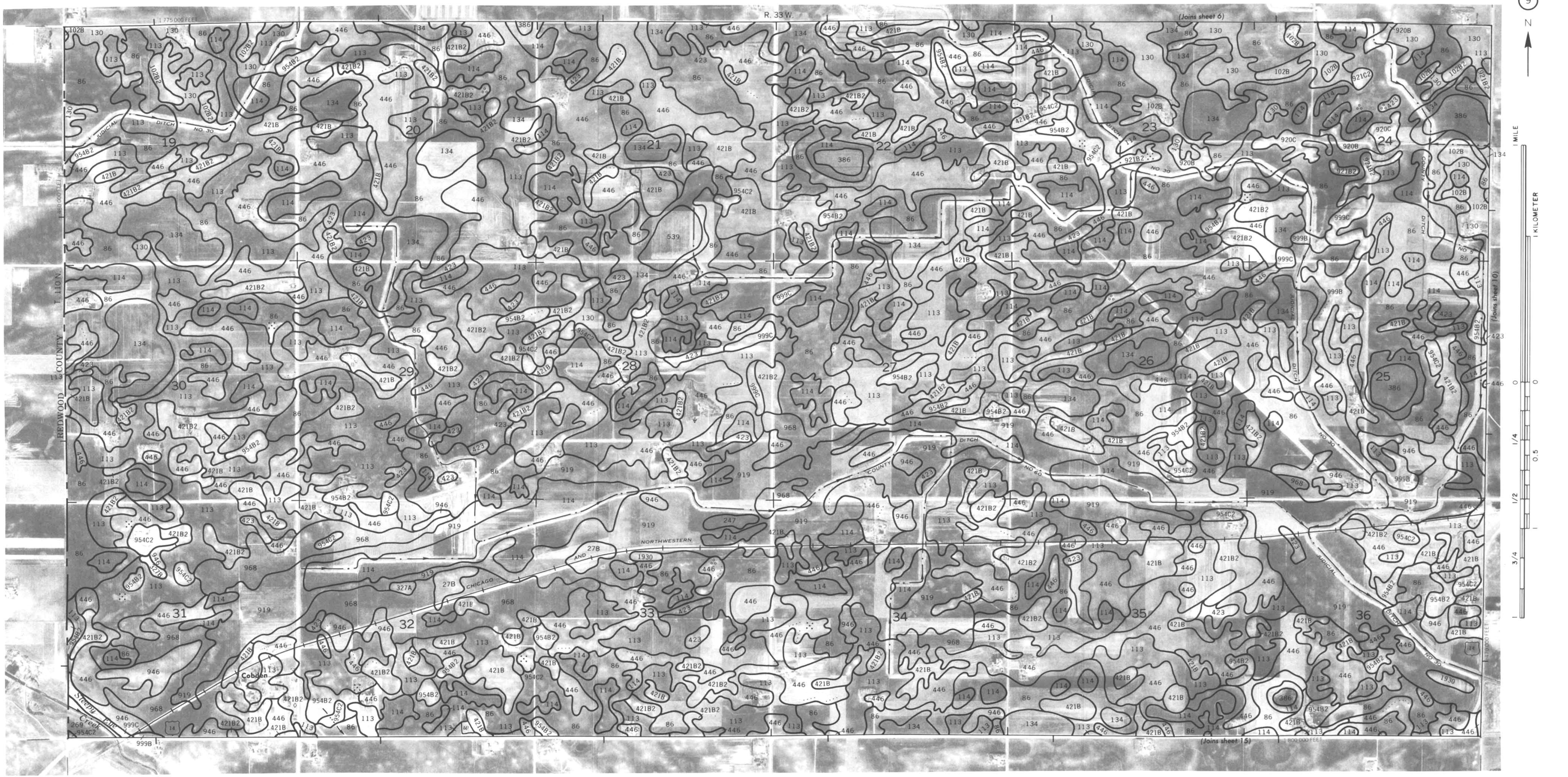

R. 31 W.
R. 32 W.
T. 111 N.
NICOLLET COUNTY
MINNESOTA
RIVER
Horseshoe Lake
(Joins sheet 2)
(Joins sheet 4)
(Joins sheet 7)
(Joins sheet 8)
N
1 MILE
1 KILOMETER


6
N
1 MILE
1 KILOMETER
0
0.5
1
1/4
1/2
3/4
REDWOOD COUNTY
R. 38 W.
T. 110 N.
(Joins sheet 3)
(Joins sheet 7)
(Joins sheet 9)
Evan
Krueger Lakebed
JUDICIAL DITCH NO 14
JUDICIAL DITCH NO 30
COUNTY DITCH NO 3
1805000 FEET
500000 FEET

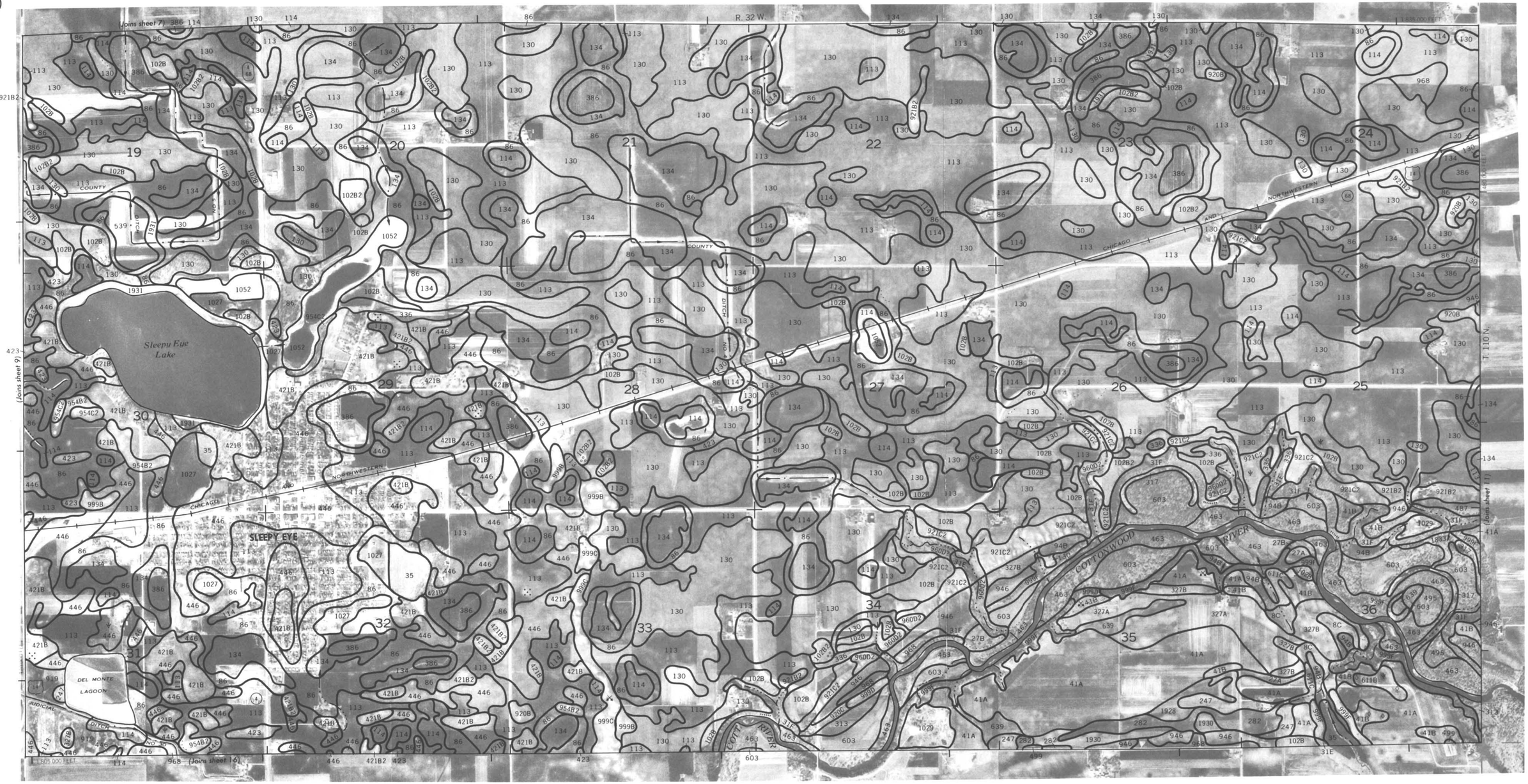
BROWN COUNTY, MINNESOTA — SHEET NUMBER 7



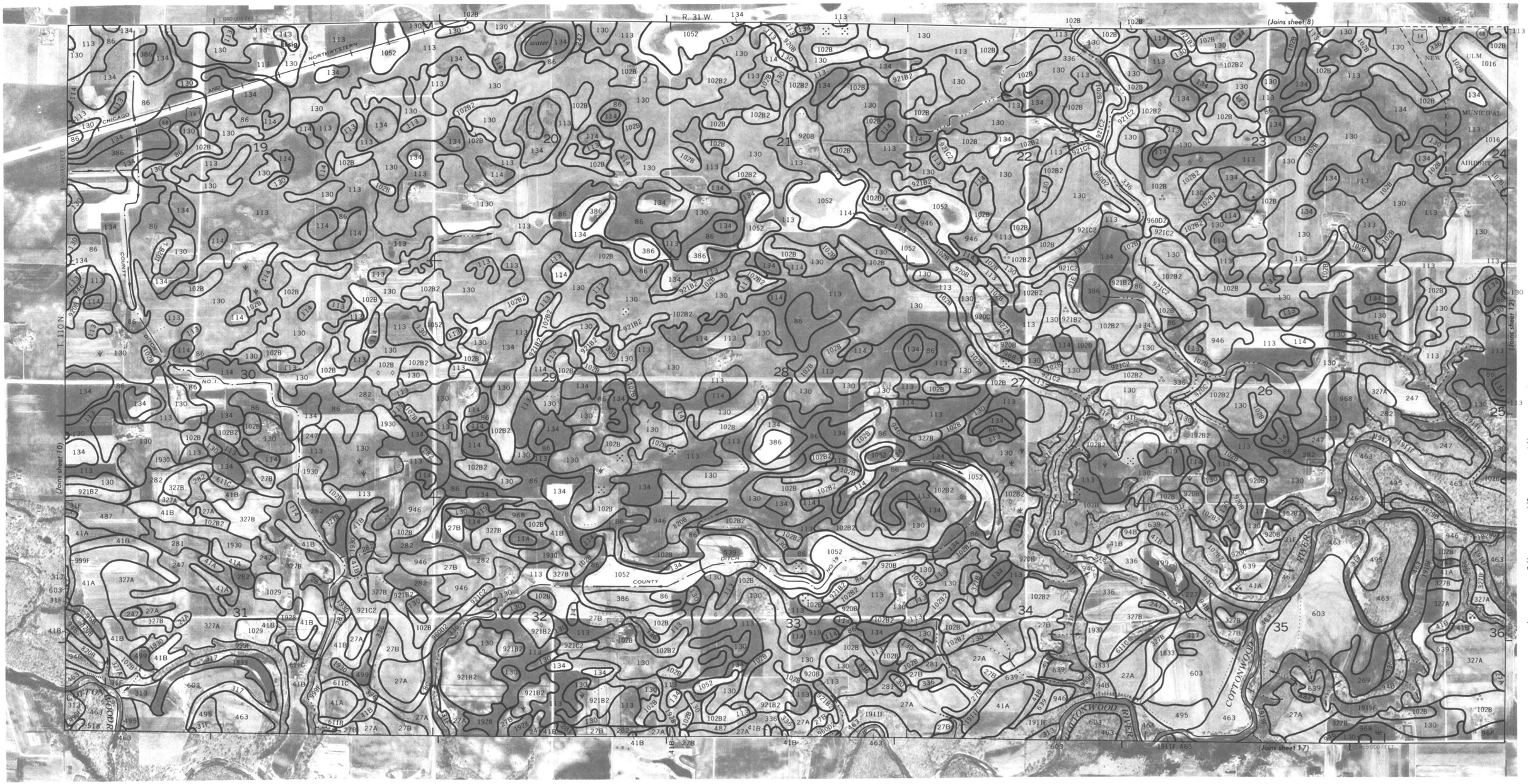

8
N
1 MILE
1 KILOMETER
0
0
1/4
0.5
1/2
3/4
R 31 W.
T. 110 N.
(Joins sheet 5)
(Joins sheet 7)
(Joins sheet 11)
(Joins inset sheet 1)
NICOLLET COUNTY
MINNESOTA RIVER
NICOLLET COUNTY
Milford Monument
CHICAGO AND NORTHWESTERN
Essig
water
1 840 000 FEET
1 845 000 FEET


9
N
R. 33 W.
1 775 000 FEET
(Joins sheet 6)
(Joins sheet 10)
(Joins sheet 15)
1 800 000 FEET
T. 110 N.
REDWOOD COUNTY
JUDICIAL DITCH NO 30
COUNTY DITCH NO 30
CHICAGO AND NORTHWESTERN
Cobden
Sleepy Eye Creek
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
1
0.5

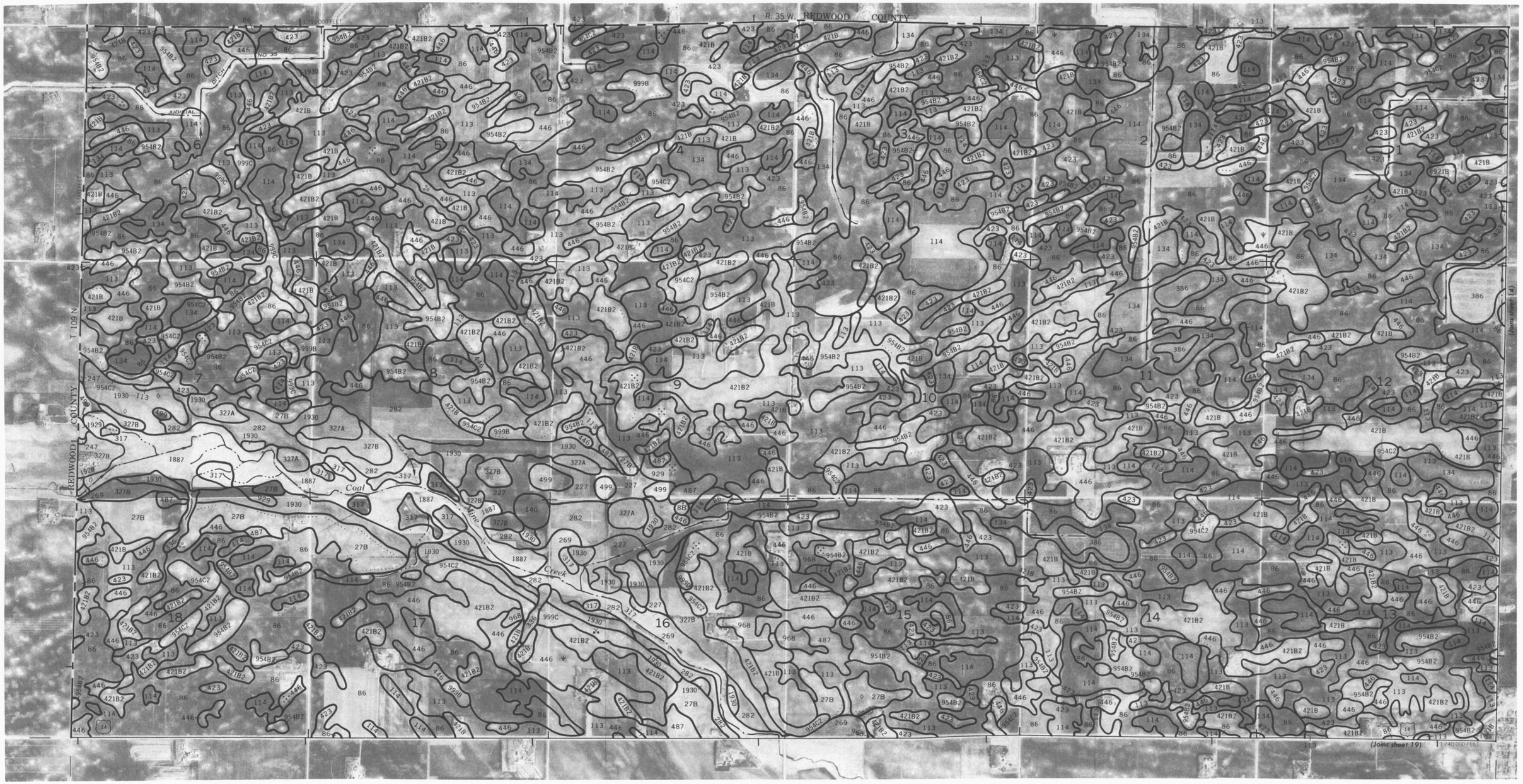
BROWN COUNTY, MINNESOTA — SHEET NUMBER 10

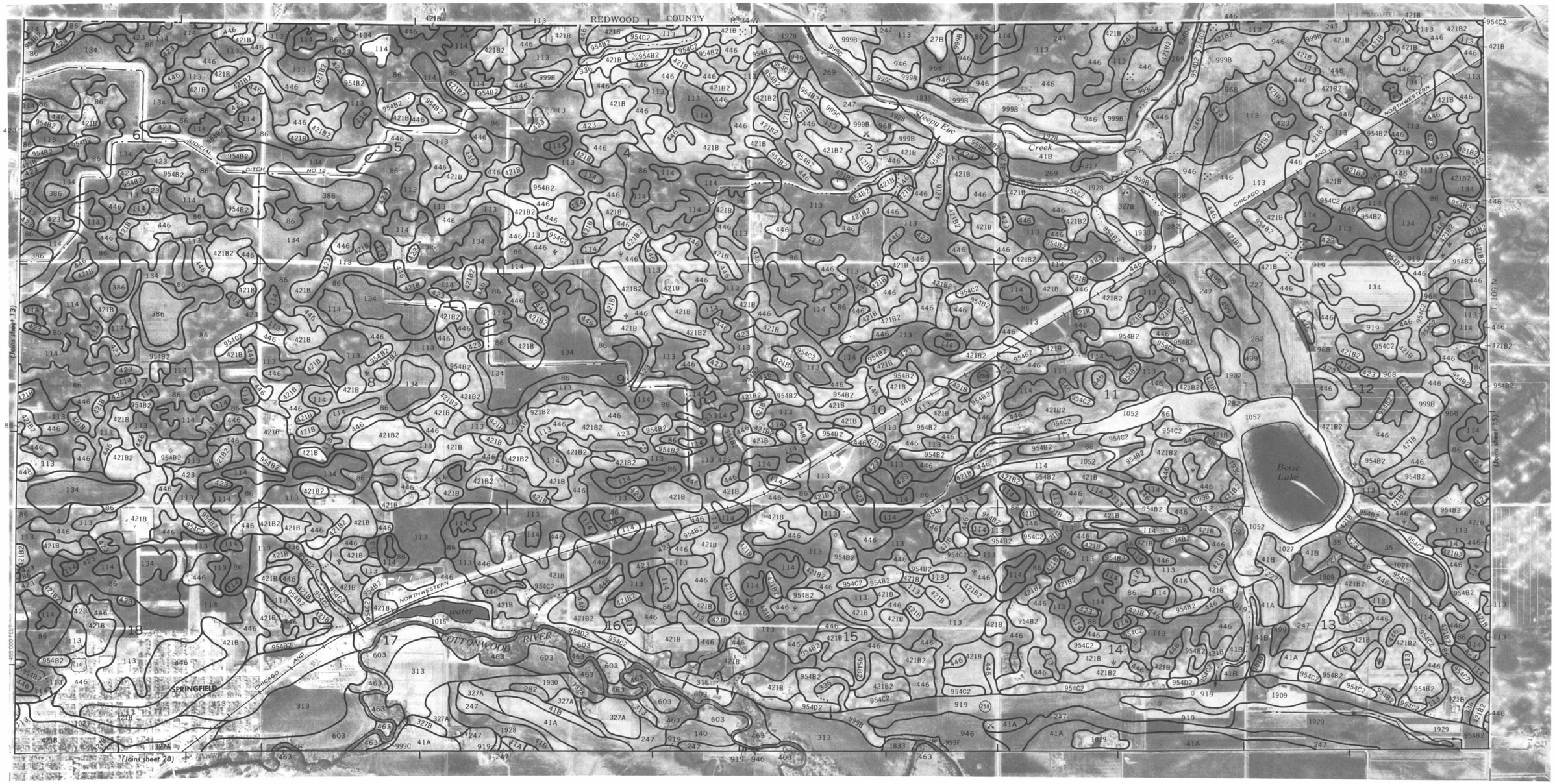


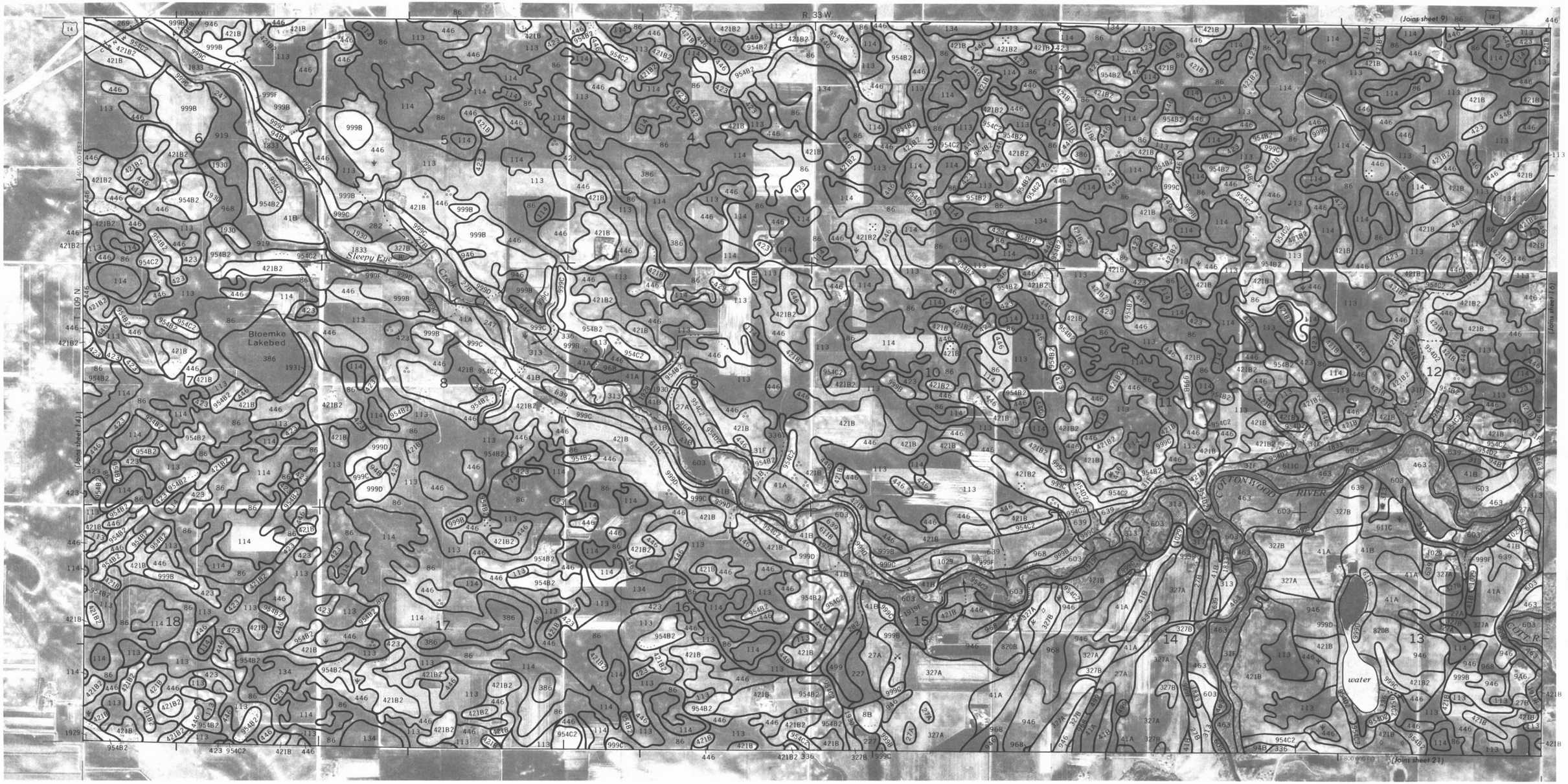
BROWN COUNTY, MINNESOTA — SHEET NUMBER 11

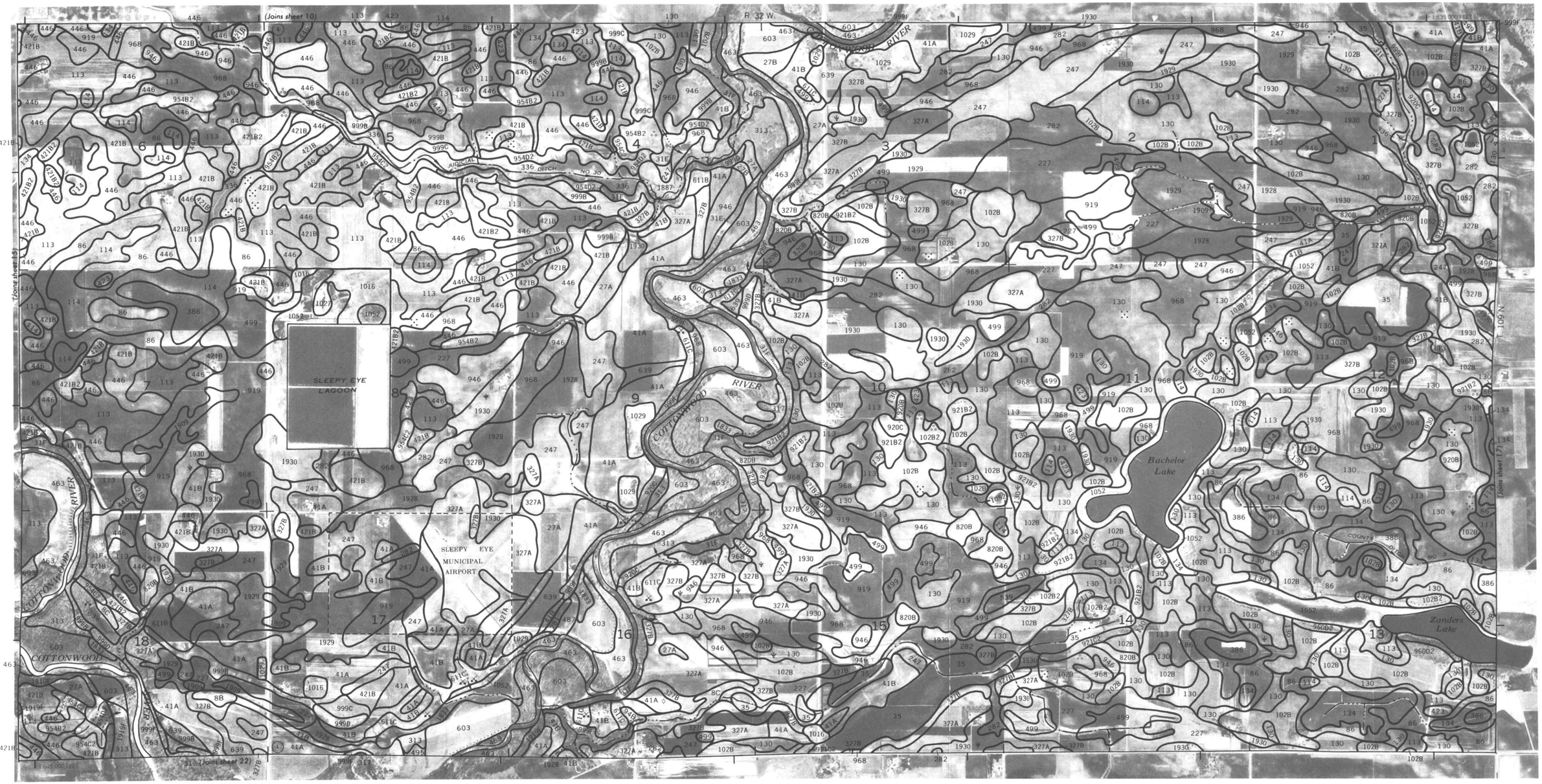


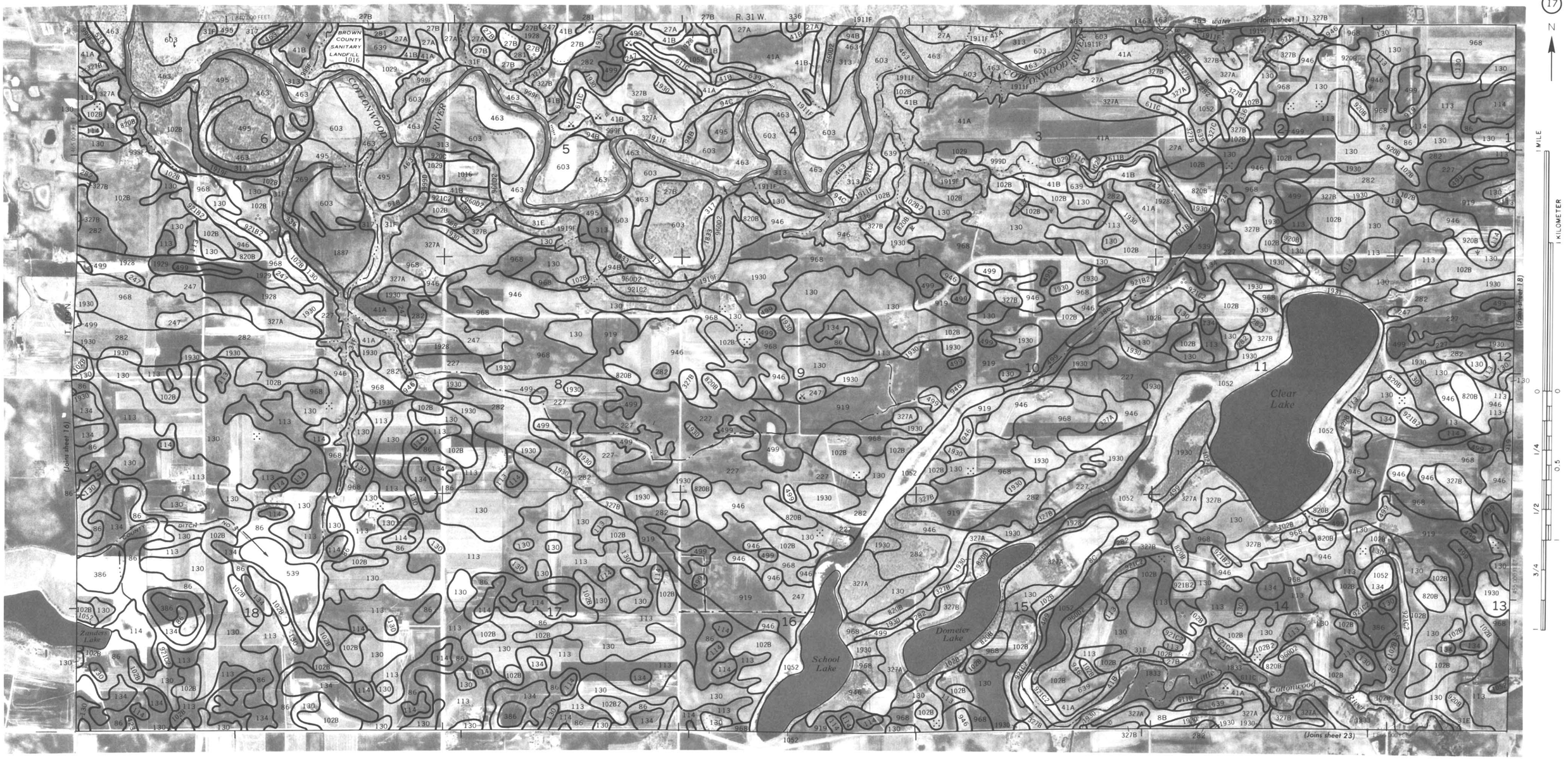

12
N
R. 31 W.
R. 30 W.
(Joins inset, sheet 1)
NEW ULM
MUNICIPAL AIRPORT
BROWN COUNTY FAIRGROUNDS
NEW ULM
(County seat)
MARTIN LUTHER COLLEGE
FLANDRAU
STATE PARK
COTTONWOOD RIVER
MINNESOTA RIVER
NICOLLET COUNTY DITCH 27
(Joins sheet 11)
(Joins sheet 18)
T. 110 N.
1 MILE
1 KILOMETER
0
0
1/4
0.5
1/2
1
3/4

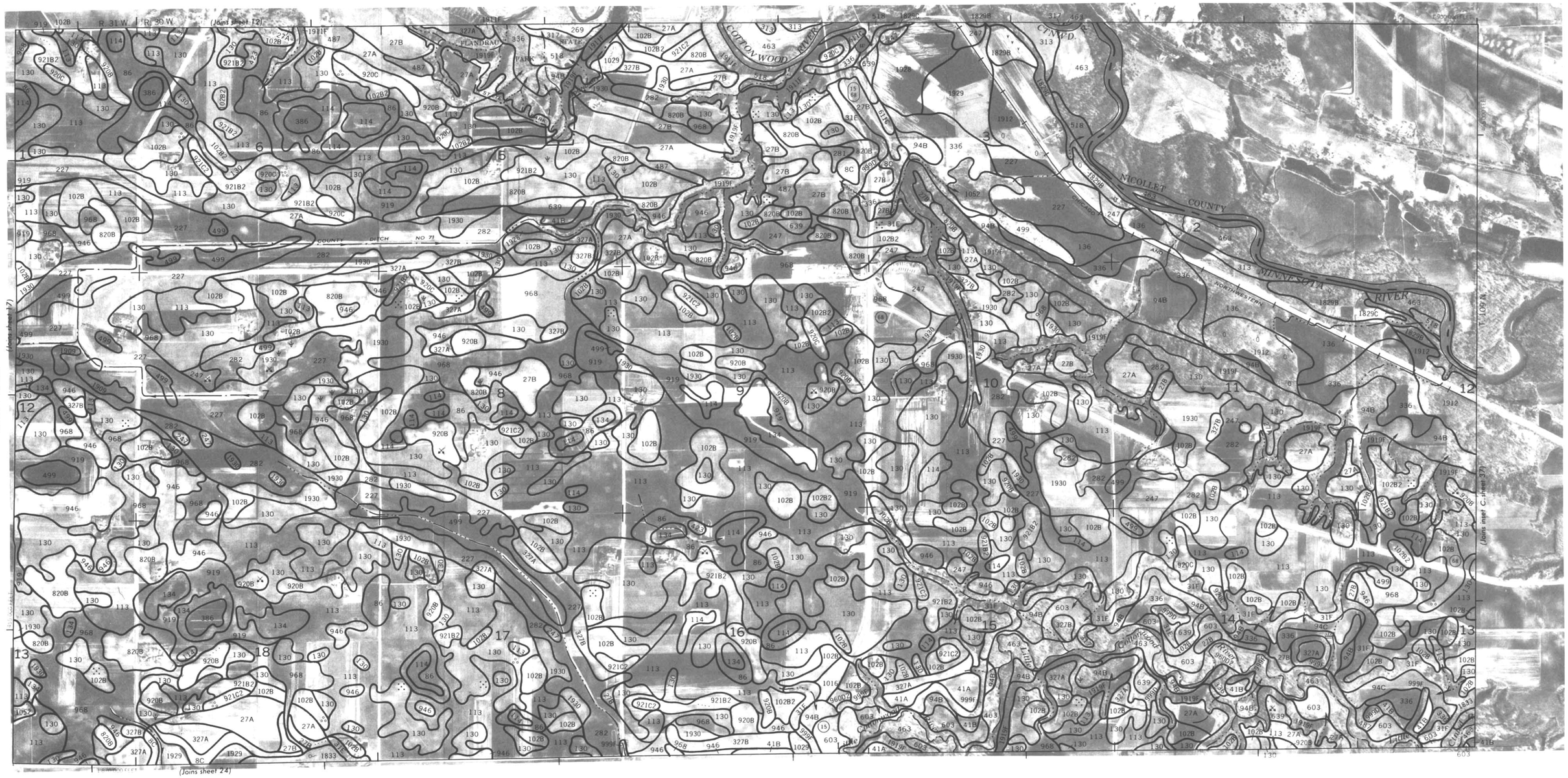

R. 35 W.
REDWOOD COUNTY
T. 109 N.
REDWOOD COUNTY
Coal Mine Creek
(Joins sheet 14)
(Joins sheet 19)
13
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5
1
2000000 FEET

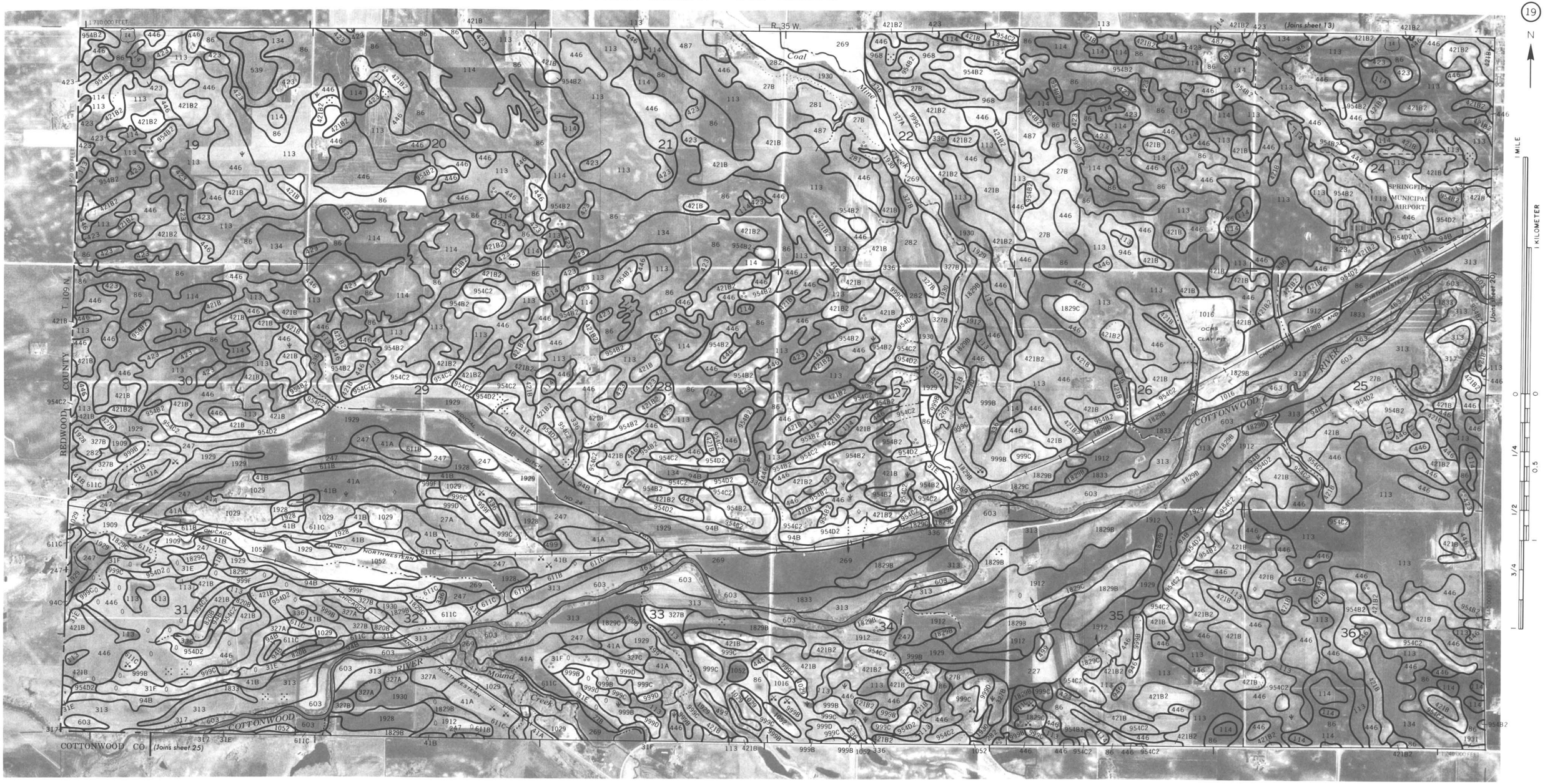

14
N
1 MILE
1 KILOMETER
1000 FEET
REDWOOD COUNTY
R. 34 W.
T. 109 N.
Sleepy Eye Creek
Boise Lake
Cottonwood River
SPRINGFIELD
NORTHWESTERN
CHICAGO AND
JUDICIAL DITCH NO. 12
(Joins sheet 13)
(Joins sheet 15)
(Joins sheet 20)


R. 33 W.
T. 109 N.
(Joins sheet 9)
(Joins sheet 14)
(Joins sheet 16)
(Joins sheet 21)
Sleepy Eye
Bloemke Lakebed
Cottonwood River
Cutter
water
15
N
1 MILE
1 KILOMETER
0
0
1/4
0.5
1/2
3/4

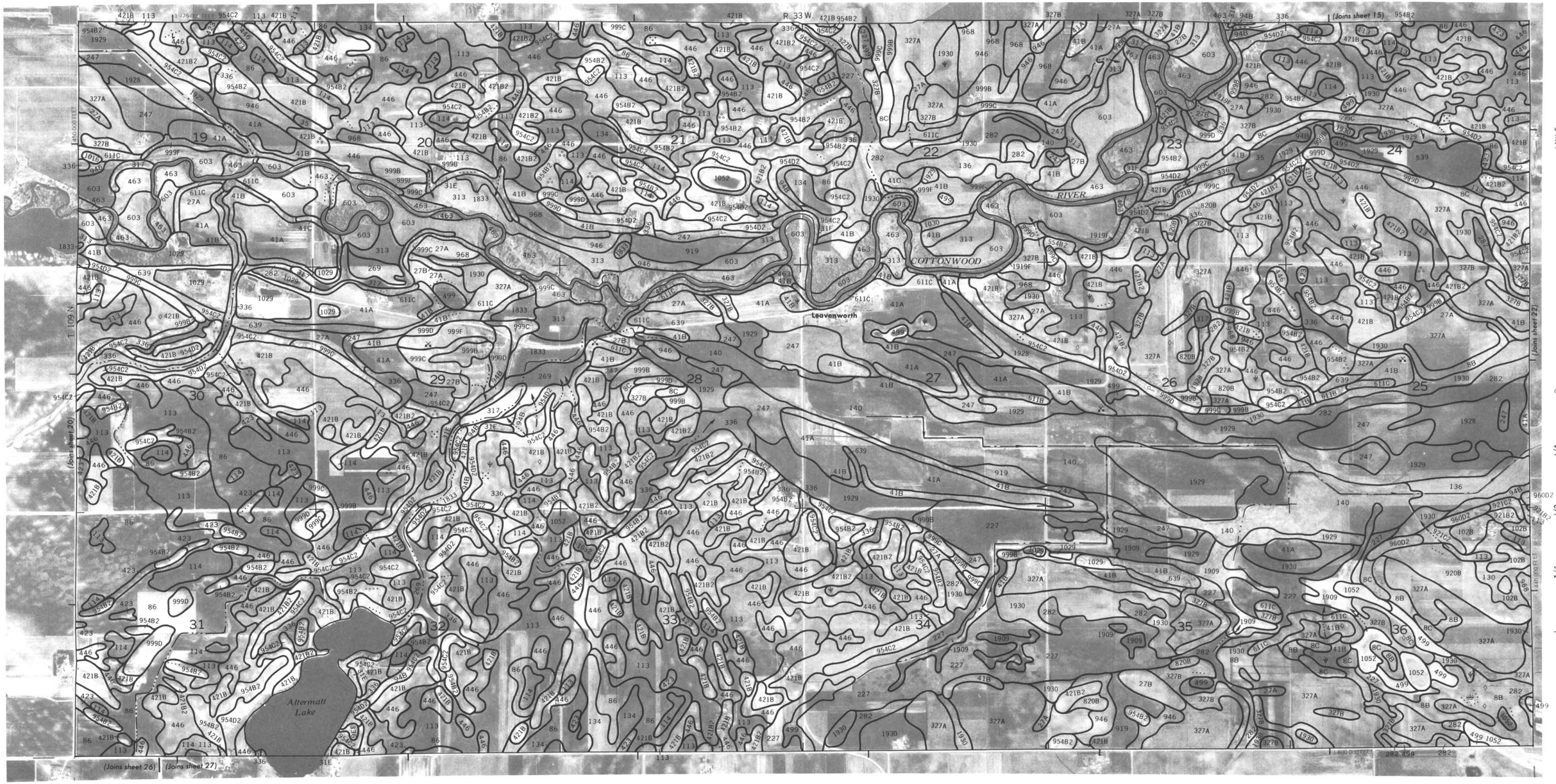

16
N
1 MILE
1 KILOMETER
0
0
0.5
1/4
1/2
3/4
(Joins sheet 10)
(Joins sheet 15)
(Joins sheet 17)
(Joins sheet 22)
R 32 W.
T 109 N.
SLEEPY EYE LAGOON
SLEEPY EYE MUNICIPAL AIRPORT
COTTONWOOD RIVER
JUDICIAL DITCH NO 30
COUNTY DITCH NO 3
Bachelor Lake
Zanders Lake
1 835 000 FEET


R. 31 W.
T. 109 N.
BROWN COUNTY SANITARY LANDFILL
COTTONWOOD RIVER
Clear Lake
School Lake
Dometer Lake
Zandstra Lake
Little Cottonwood River
DITCH NO. 34
(Joins sheet 16)
(Joins sheet 18)
(Joins sheet 23)
(Joins sheet 11)
water
1 MILE
1 KILOMETER
N

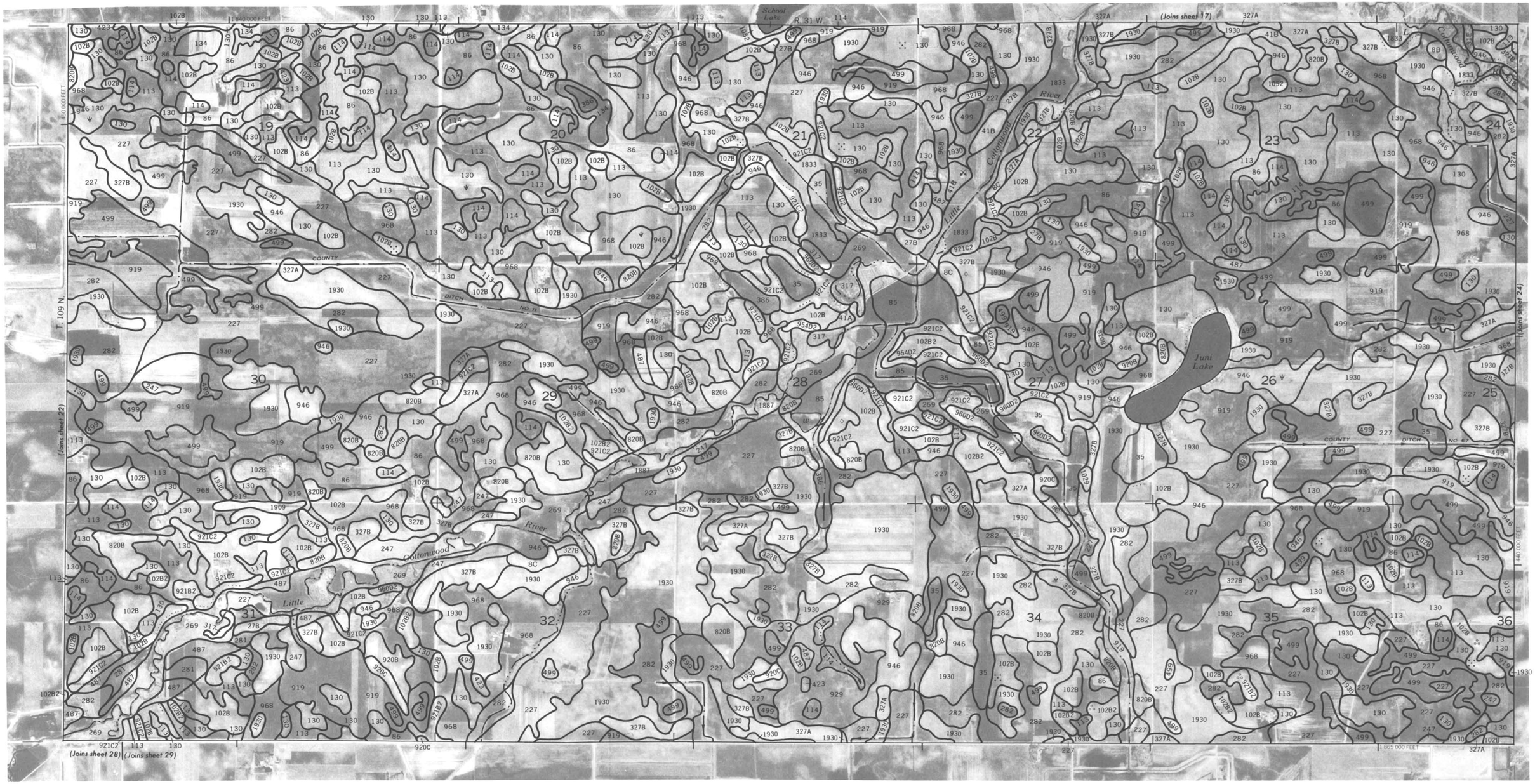

18
N
R. 31 W.
R. 30 W.
(Joins sheet 12)
(Joins sheet 17)
(Joins sheet 24)
(Joins sheet C-1 sheet 37)
T. 109 N.
COTTONWOOD RIVER
FLANDRAU STATE PARK
COUNTY DITCH NO 71
NICOLLET COUNTY
MINNESOTA RIVER
CHICAGO NORTHWESTERN
C.M.St.P.
Scale 1: 20000
1 MILE
1 KILOMETER
0
0.5
1/4
1/2
3/4

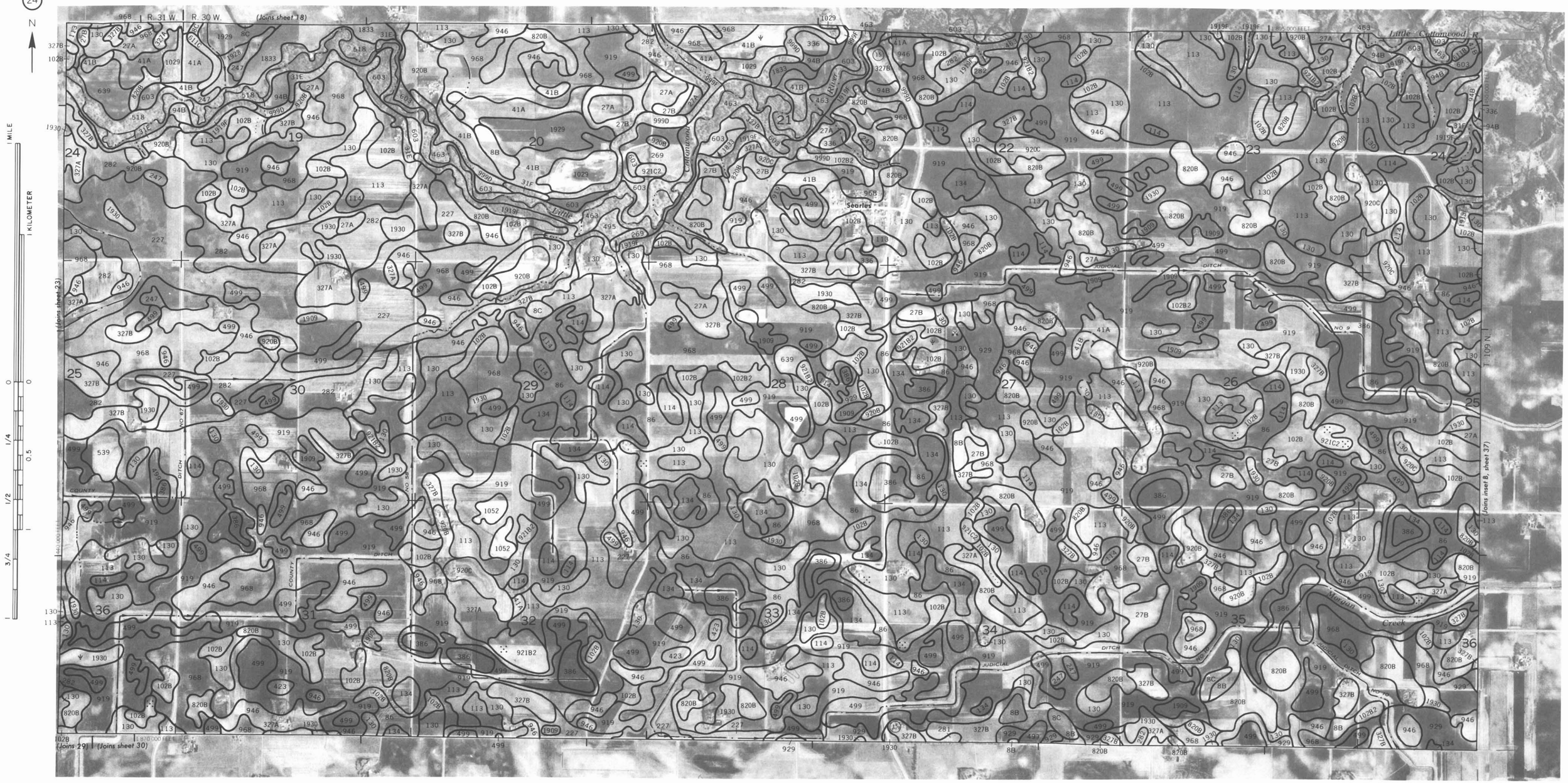

R. 35 W.
T. 109 N.
REDWOOD COUNTY
COTTONWOOD CO.
(Joins sheet 13)
(Joins sheet 20)
(Joins sheet 25)
SPRINGFIELD MUNICIPAL AIRPORT
OCHS CLAY PIT
Coal Mine Creek
Mound Creek
COTTONWOOD RIVER
CHICAGO, MILWAUKEE, ST. PAUL AND PACIFIC RAILROAD
CHICAGO, ST. PAUL, MINNEAPOLIS AND OMAHA RAILROAD
CHICAGO NORTHWESTERN RAILROAD
MEDICAL LAKE DITCH NO 24
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
1 710 000 FEET
1 720 000 FEET
N
1 MILE
1 KILOMETER


20
N
SPRINGFIELD
COTTONWOOD RIVER
Chicago, St. Paul, Minneapolis & Omaha Railway Co.
(Joins sheet 14)
(Joins sheet 19)
(Joins sheet 21)
(Joins sheet 25)
(Joins sheet 26)
R. 34 W.
T. 109 N.
1 MILE
1 KILOMETER
0
0
1/4
0.5
1/2
1
3/4
1,720,000 FEET
1,745,000 FEET

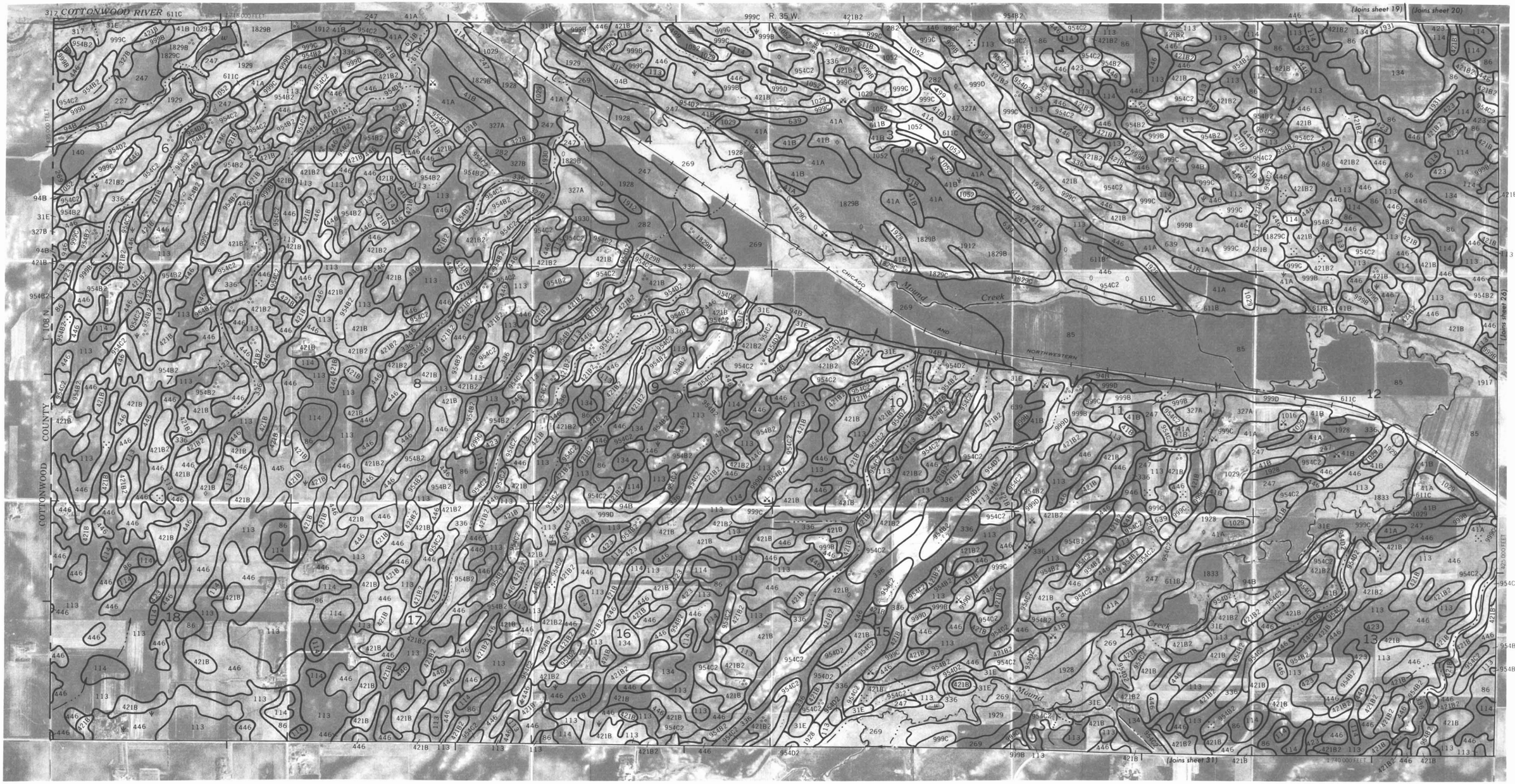

R. 33 W.
T. 109 N.
Leavenworth
COTTONWOOD
RIVER
Altermatt Lake
(Joins sheet 15)
(Joins sheet 20)
(Joins sheet 22)
(Joins sheet 26)
(Joins sheet 27)
N
1 MILE
1 KILOMETER


N
R. 32 W.
COTTONWOOD RIVER
Gilman Lake
Little Cottonwood River
(Joins sheet 21)
(Joins sheet 23)
(Joins sheet 27)
(Joins sheet 28)
1 MILE
1 KILOMETER

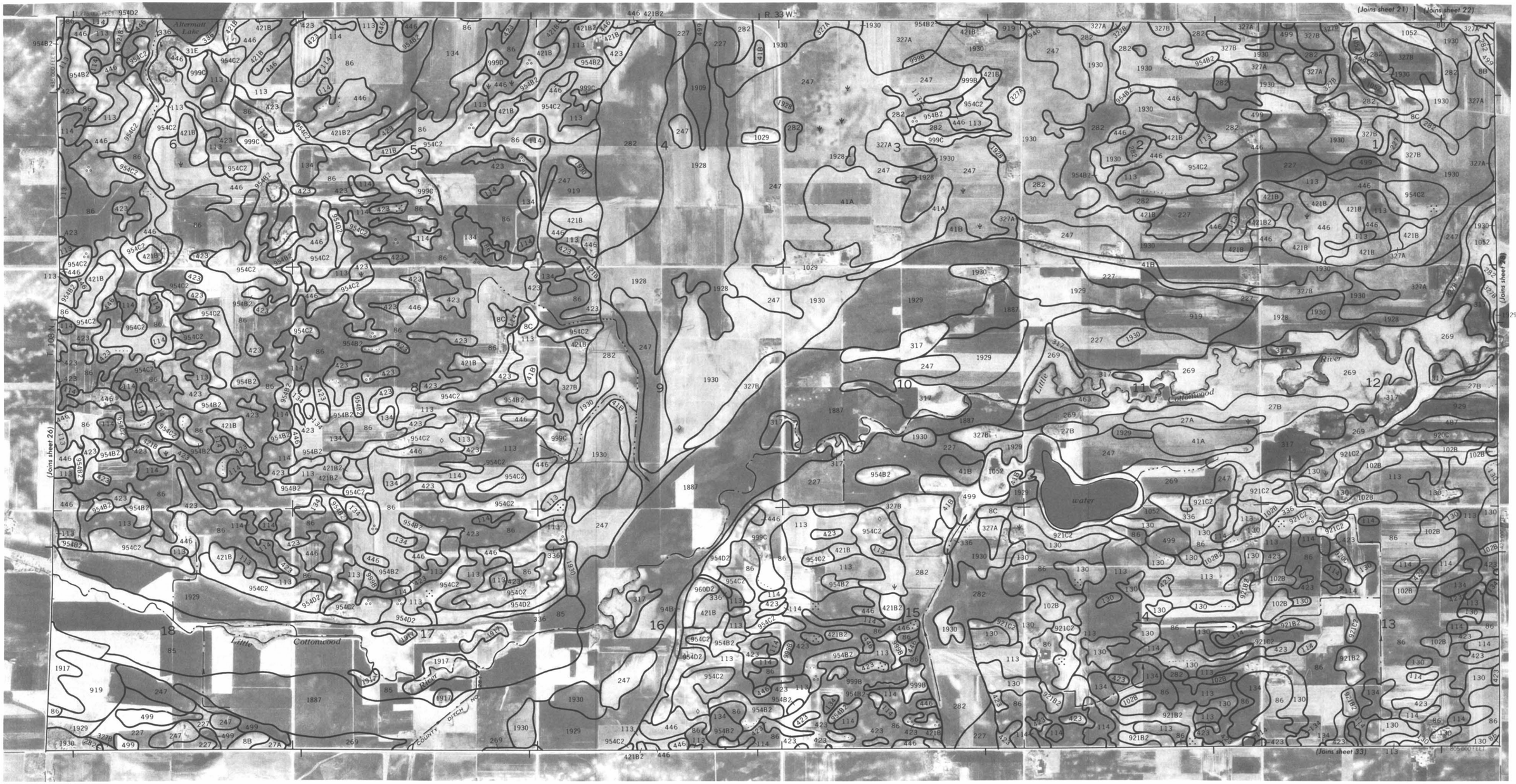

R. 31 W.
T. 109 N.
School Lake
Cottonwood River
Little Cottonwood River
Juni Lake
COUNTY DITCH NO. II
COUNTY DITCH NO. 67
(Joins sheet 17)
(Joins sheet 22)
(Joins sheet 24)
(Joins sheet 28)
(Joins sheet 29)
1 640 000 FEET
860 000 FEET
1 865 000 FEET
1 460 000 FEET
1 MILE
1 KILOMETER
N

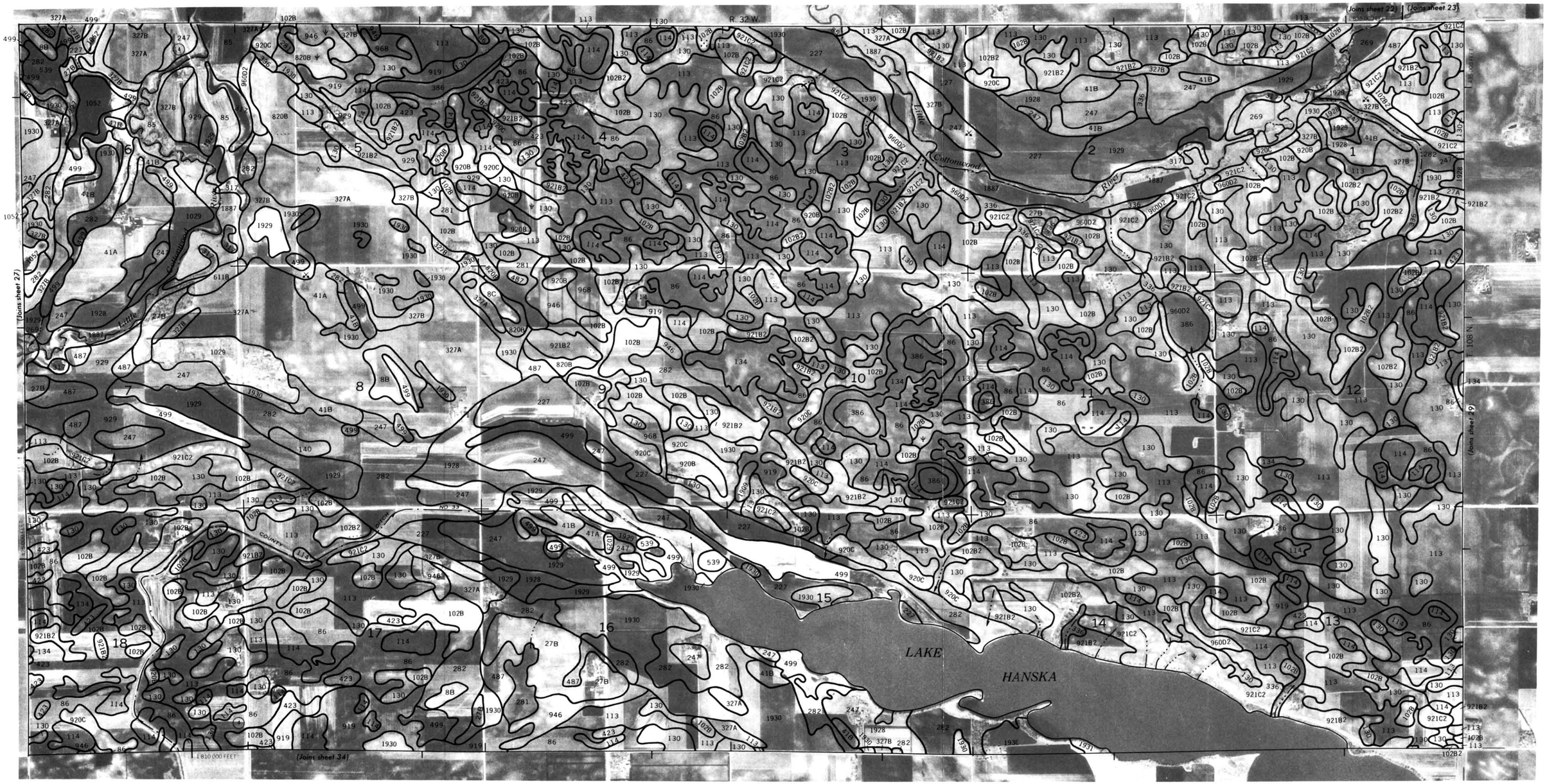

24
N
R. 31 W.
R. 30 W.
(Joins sheet 18)
(Joins sheet 23)
(Joins sheet 29)
(Joins sheet 30)
(Joins inset B, sheet 37)
T. 109 N.
1 MILE
1 KILOMETER
Little Cottonwood R.
Searles
Morgan Creek
Contourgood
DITCH
JUDICIAL DITCH
COUNTY DITCH
NO 9
NO 67
NO 68
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36

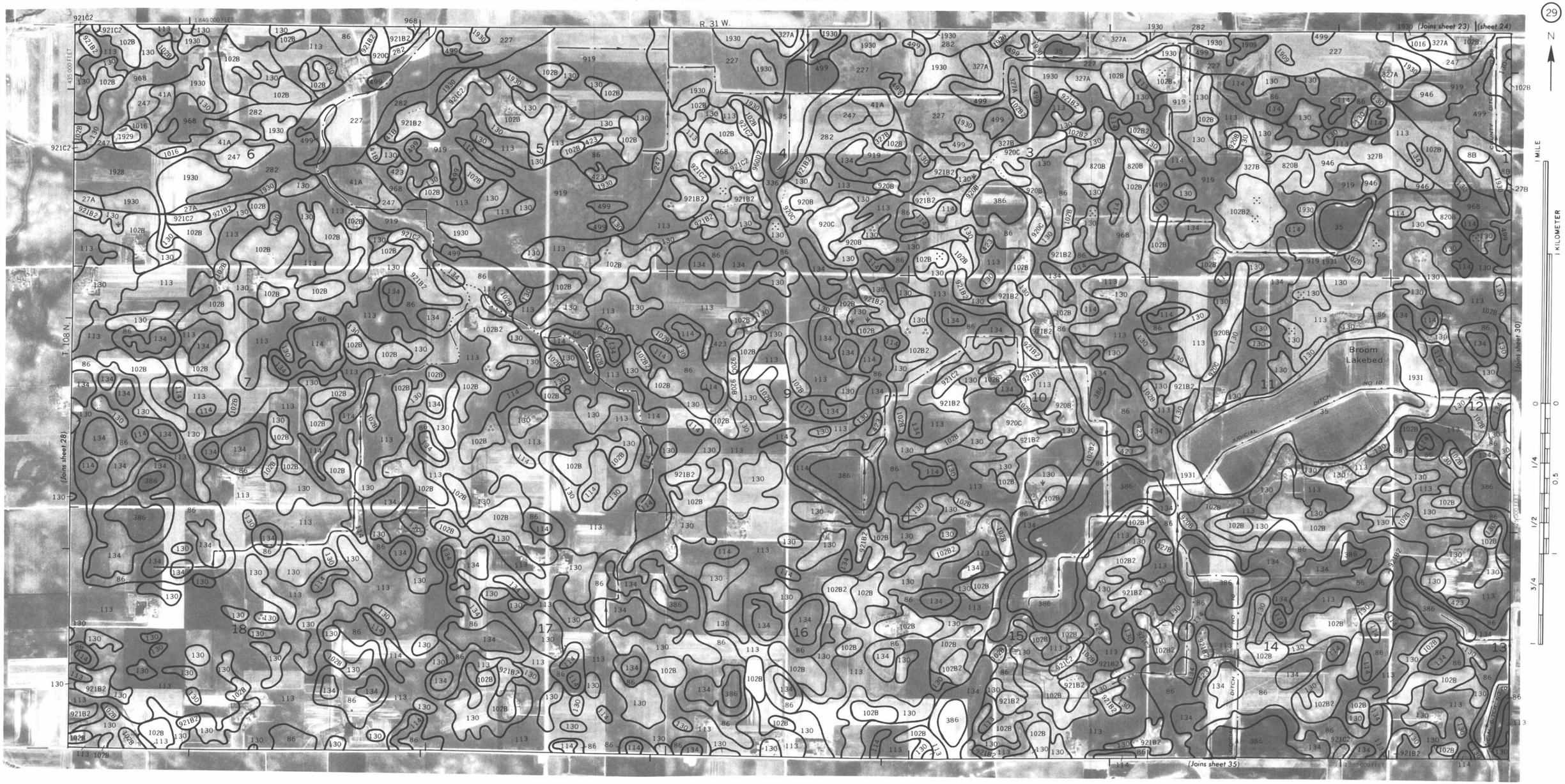
BROWN COUNTY, MINNESOTA — SHEET NUMBER 25

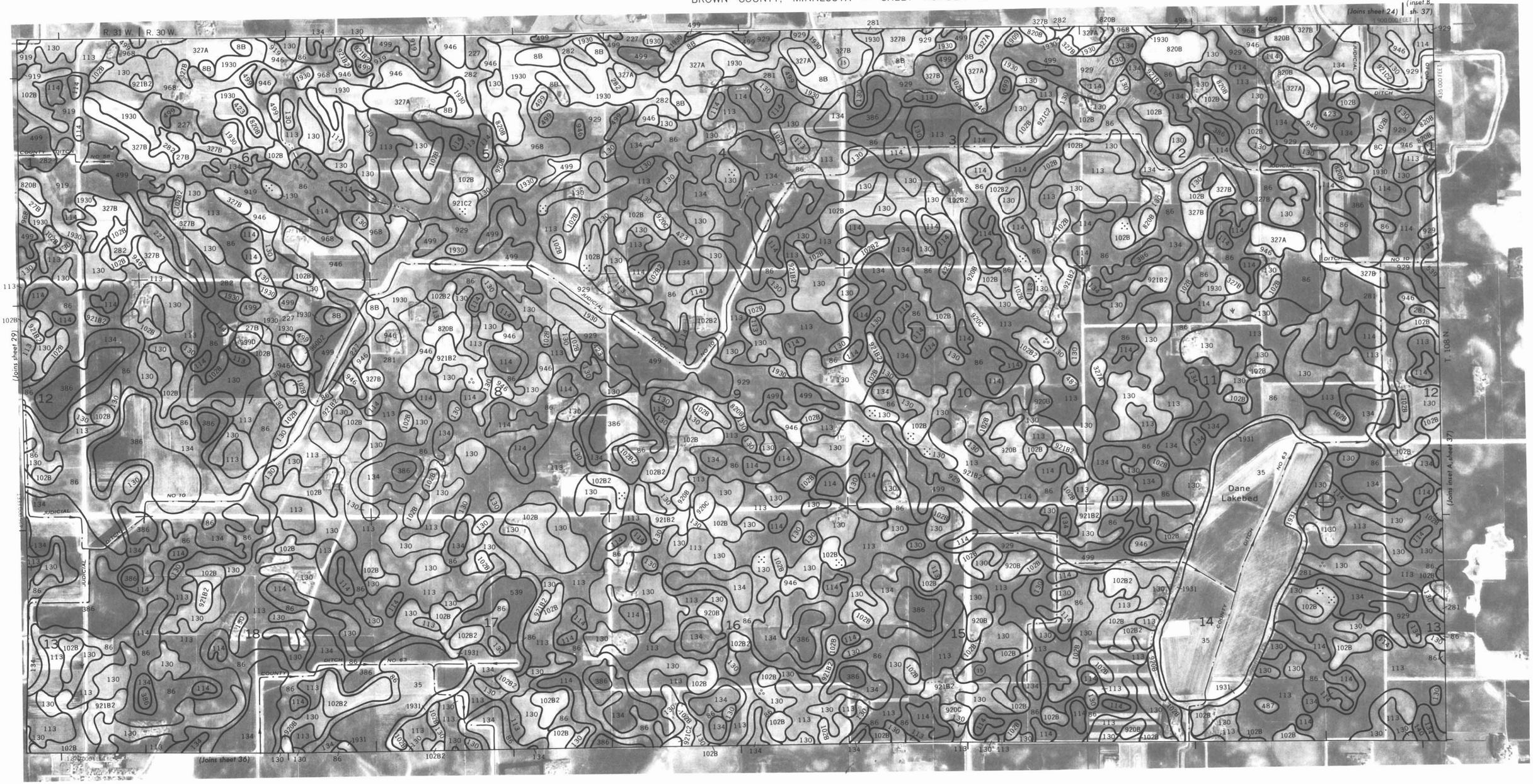



26
N
R. 34 W.
T. 108 N.
(Joins sheet 20)
(Joins sheet 21)
(Joins sheet 25)
(Joins sheet 27)
(Joins sheet 32)
Reed
Lakebed
Cottonwood
River
Little
BASHAW
STATE WILDLIFE MANAGEMENT AREA
1 MILE
1 KILOMETER

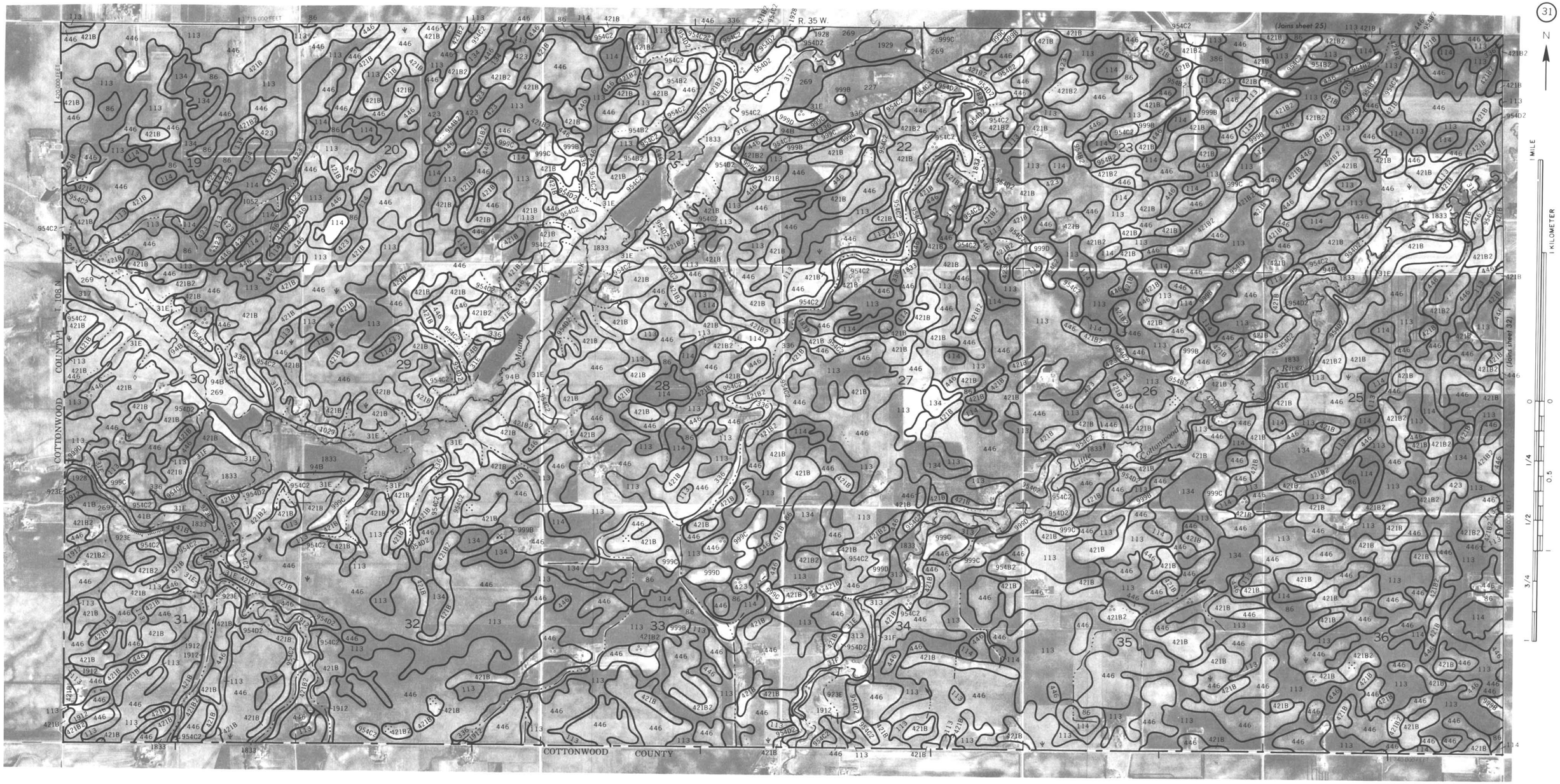

R. 33 W.
T. 108 N.
(Joins sheet 21)
(Joins sheet 22)
(Joins sheet 26)
(Joins sheet 28)
(Joins sheet 33)
Altermatt Lake
Little Cottonwood River
Little Cottonwood River
water
COUNTY DITCH NO.
27
N
1 MILE
1 KILOMETER
0
0
1/4
0.5
1/2
3/4
1


28
N
1 MILE
1 KILOMETER
R. 32 W.
T. 108 N.
(Joins sheet 22)
(Joins sheet 23)
(Joins sheet 27)
(Joins sheet 29)
(Joins sheet 34)
LAKE
HANSKA
Little Cottonwood River
Cottonwood River
COUNTY ROAD NO. 33
1810 000 FEET
258 000 FEET

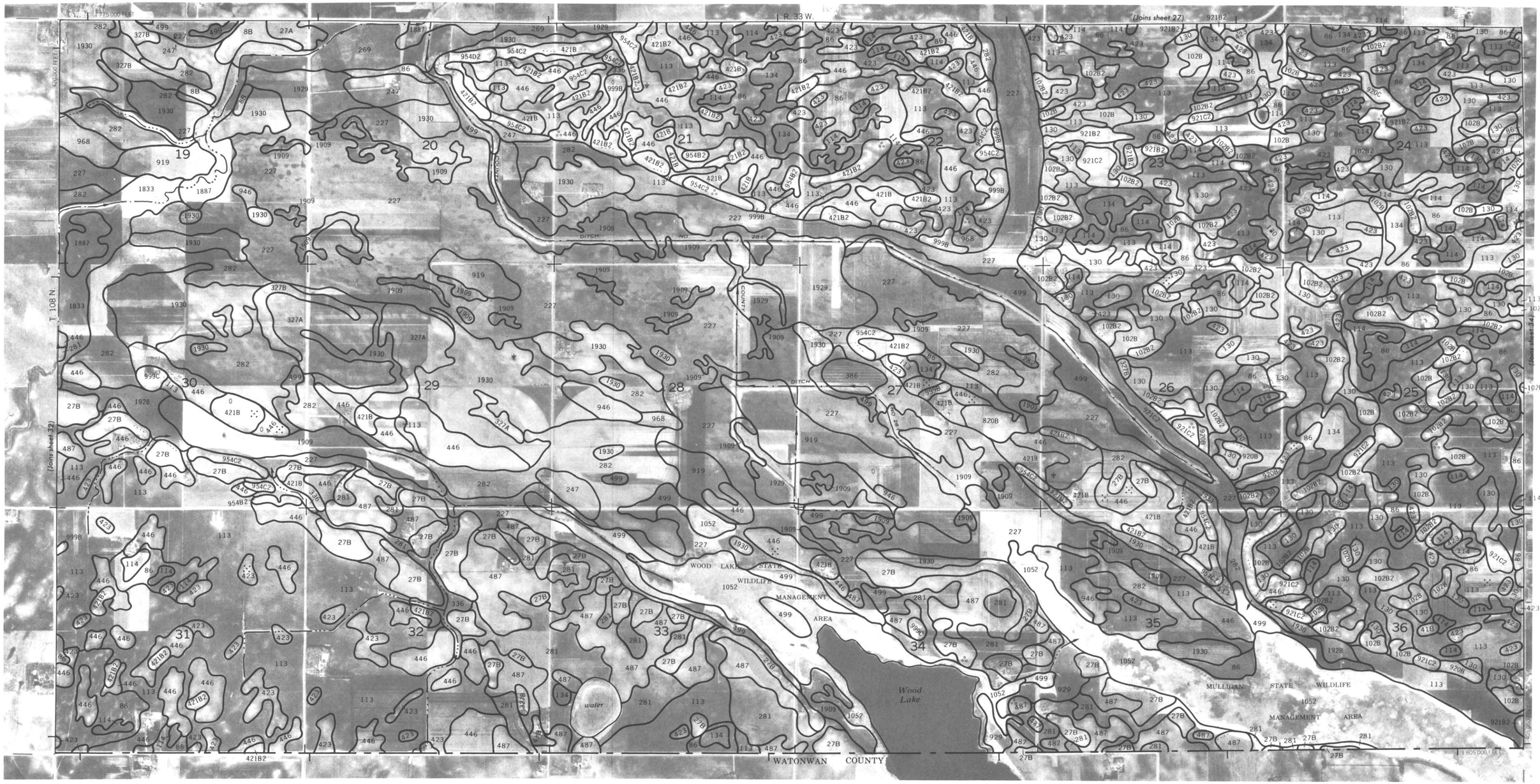

R. 31 W.
T. 108 N.
1 840 000 FEET
435 000 FEET
(Joins sheet 23)
(sheet 24)
(Joins sheet 28)
(Joins sheet 30)
(Joins sheet 35)
Broom Lakebed
DITCH
JUDICIAL
29
N
1 MILE
1 KILOMETER
0
1/4
1/2
3/4
0.5

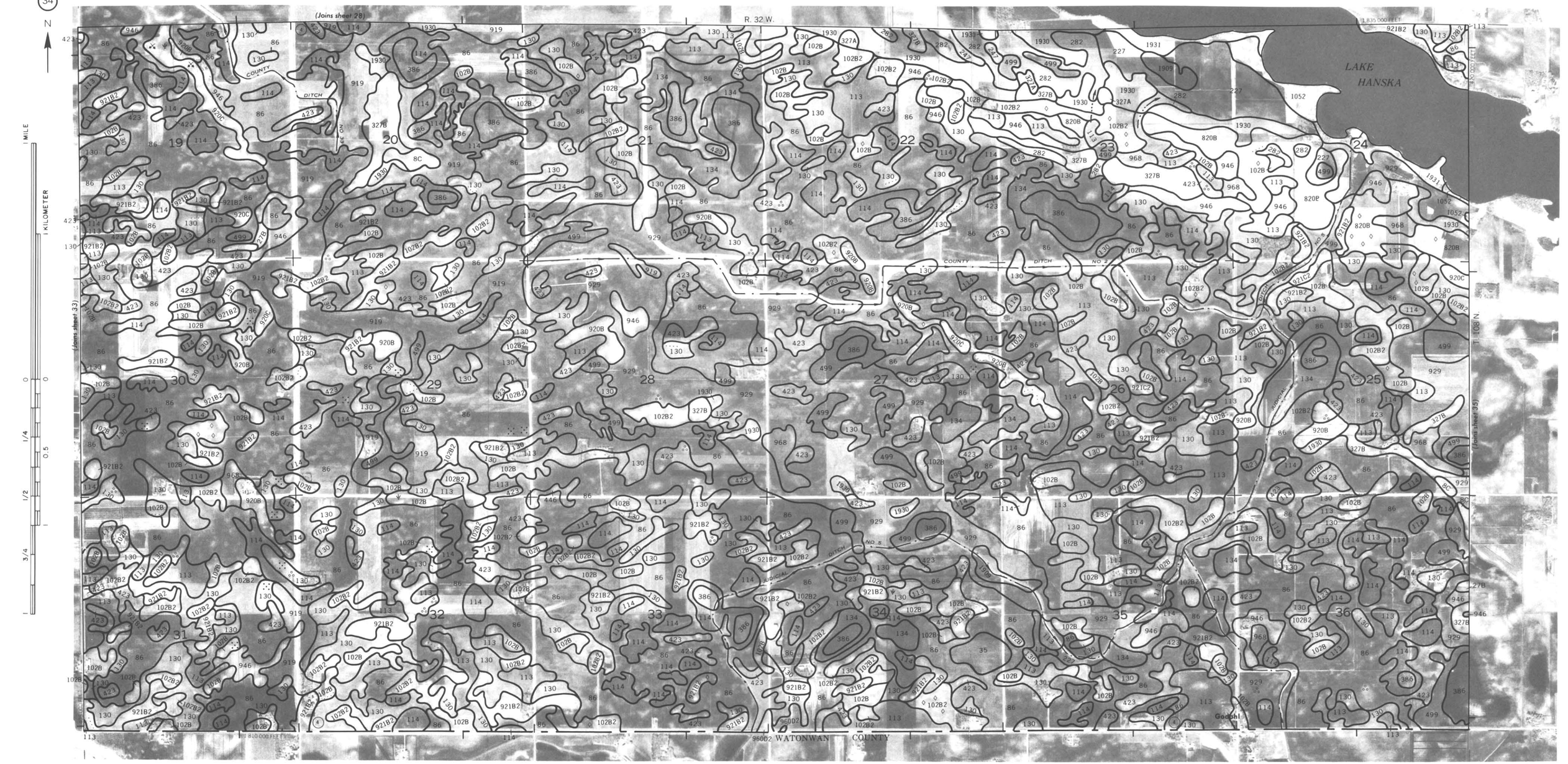

30
N
R. 31 W.
R. 30 W.
T. 108 N
1 MILE
1 KILOMETER
(Joins sheet 29)
(Joins sheet 24)
(Inset B sh. 37)
(Joins inset A sheet 37)
(Joins sheet 36)
1,500,000 FEET
435,000 FEET
Dane Lakebed
JUDICIAL DITCH NO 10
COUNTY DITCH NO 63
COUNTY DITCH NO 58

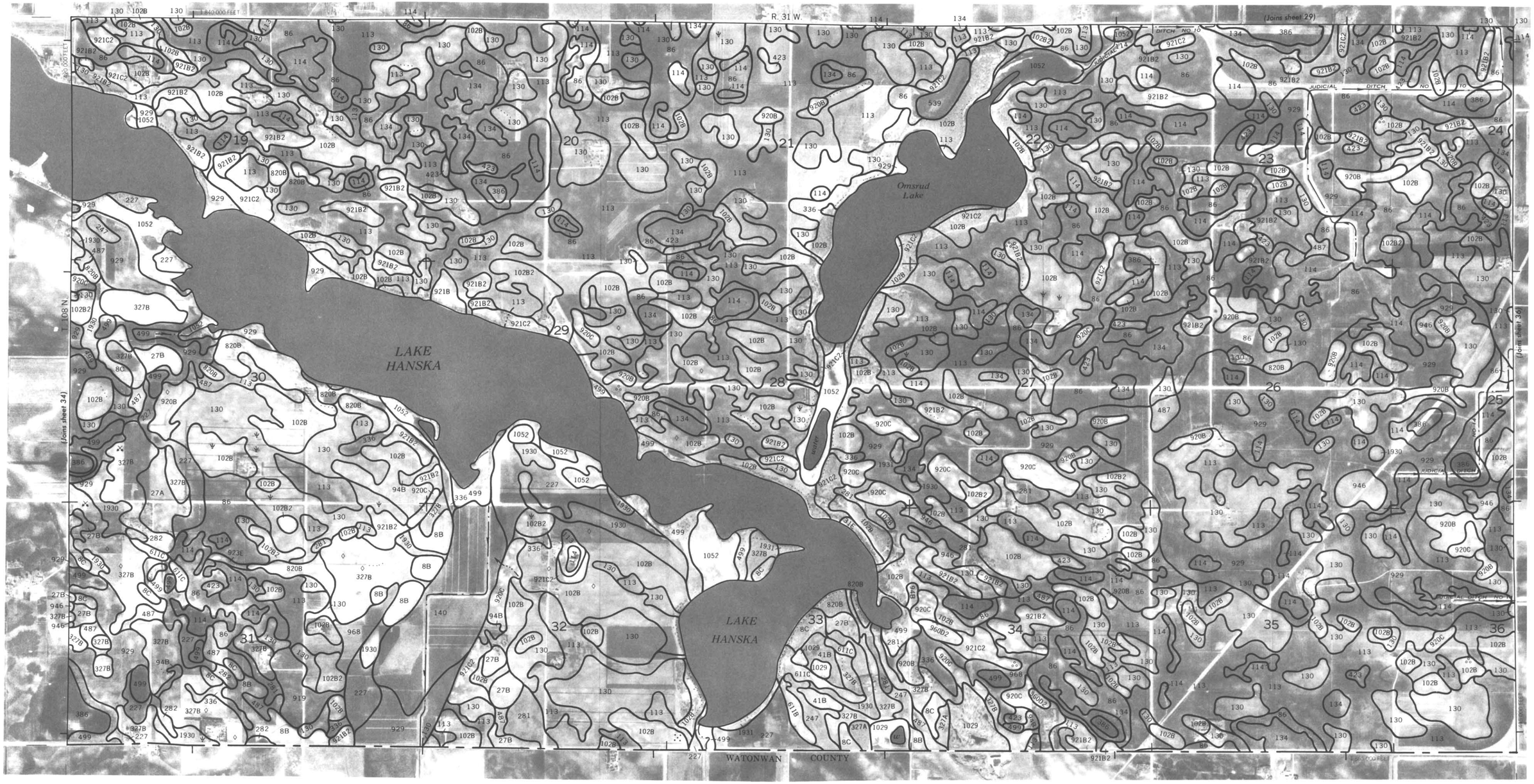
BROWN COUNTY, MINNESOTA — SHEET NUMBER 31

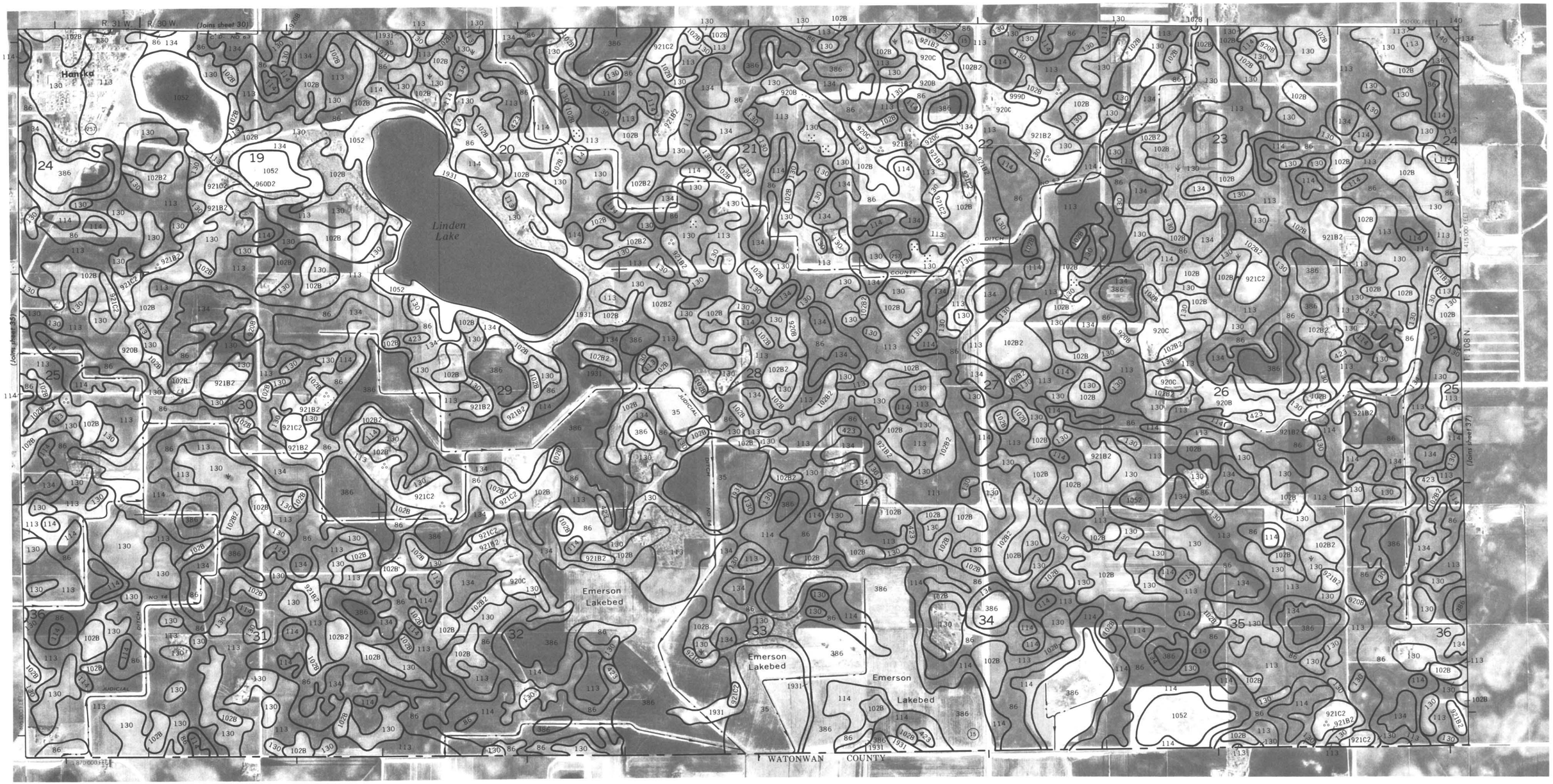



32
N
1 MILE
1 KILOMETER
(Joins sheet 26)
(Joins sheet 31)
(Joins sheet 33)
R. 34 W.
T. 108 N.
BASHAW STATE WILDLIFE MANAGEMENT AREA
317
Little Cottonwood River
Comfrey
COTTONWOOD COUNTY
1 770 000 FEET
1 745 000 FEET

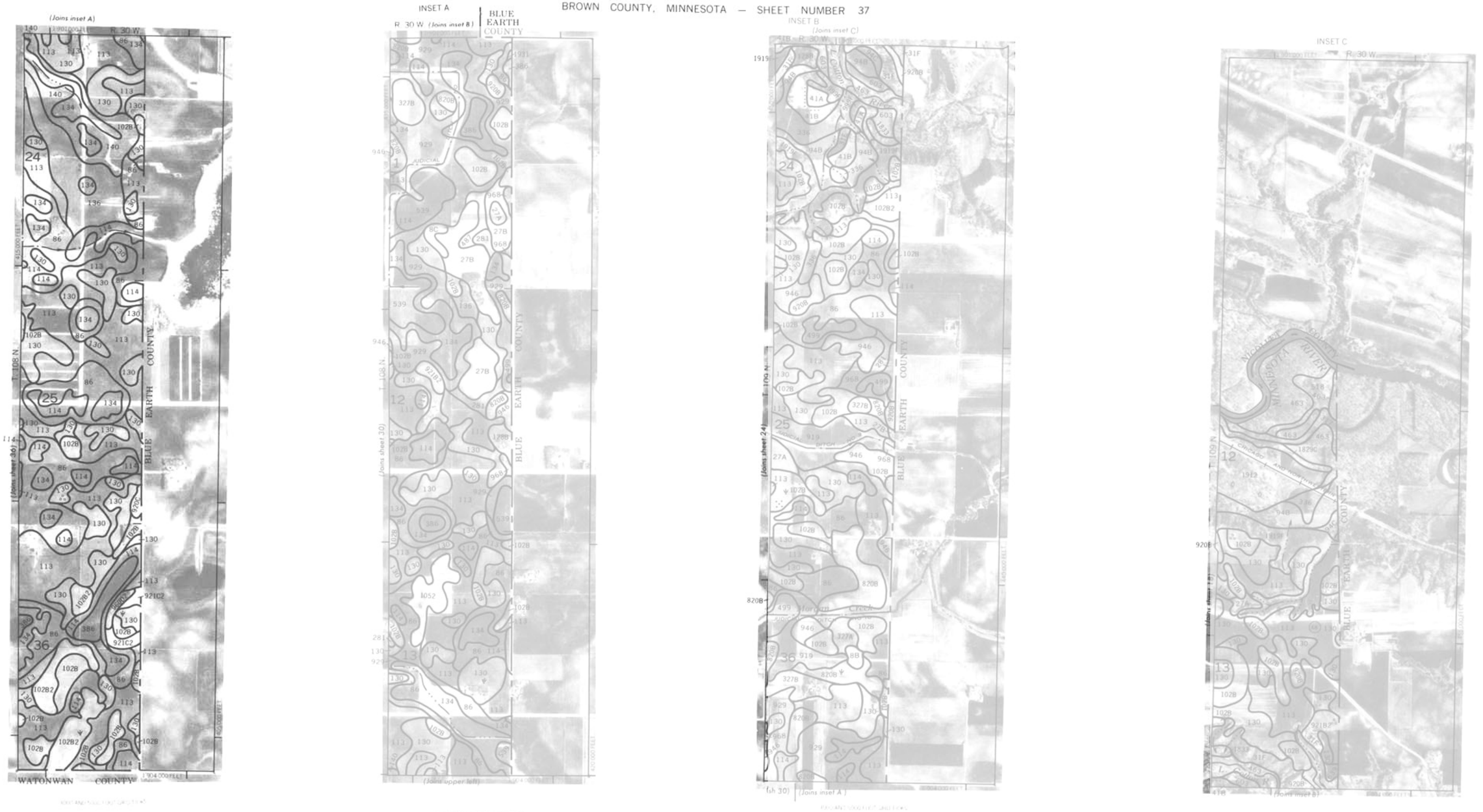

33
N
R. 33 W.
T. 108 N.
(Joins sheet 27)
(Joins sheet 32)
(Joins sheet 34)
WATONWAN COUNTY
Wood Lake
water
WOOD LAKE STATE WILDLIFE MANAGEMENT AREA
MULLIGAN STATE WILDLIFE MANAGEMENT AREA
DITCH NO. 284
COUNTY DITCH NO. 28
1 MILE
1 KILOMETER
0
0.5
1/4
1/2
3/4
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36


34
N
(Joins sheet 28)
R. 32 W.
LAKE HANSKA
1,835,000 FEET
430,000 FEET
T. 108 N.
(Joins sheet 33)
(Joins sheet 35)
COUNTY DITCH NO. 39
COUNTY DITCH NO. 2
COUNTY DITCH NO. 5
JUDICIAL DITCH
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
WATONWAN COUNTY
810,000 FEET
1 MILE
1 KILOMETER
0
0.5
1/4
1/2
3/4
1


R. 31 W.
108 N.
LAKE HANSKA
LAKE HANSKA
Omsrud Lake
(Joins sheet 29)
(Joins sheet 34)
(Joins sheet 36)
WATONWAN COUNTY
N
1 MILE
1 KILOMETER


36
N
R. 31 W.
R. 30 W.
(Joins sheet 30)
Hanska
Linden Lake
Emerson Lakebed
Emerson Lakebed
Emerson Lakebed
WATONWAN COUNTY
(Joins sheet 35)
(Joins sheet 37)
T 108 N.
1 MILE
1 KILOMETER
0
0.5
1
1/4
1/2
3/4

BROWN COUNTY, MINNESOTA — SHEET NUMBER 37

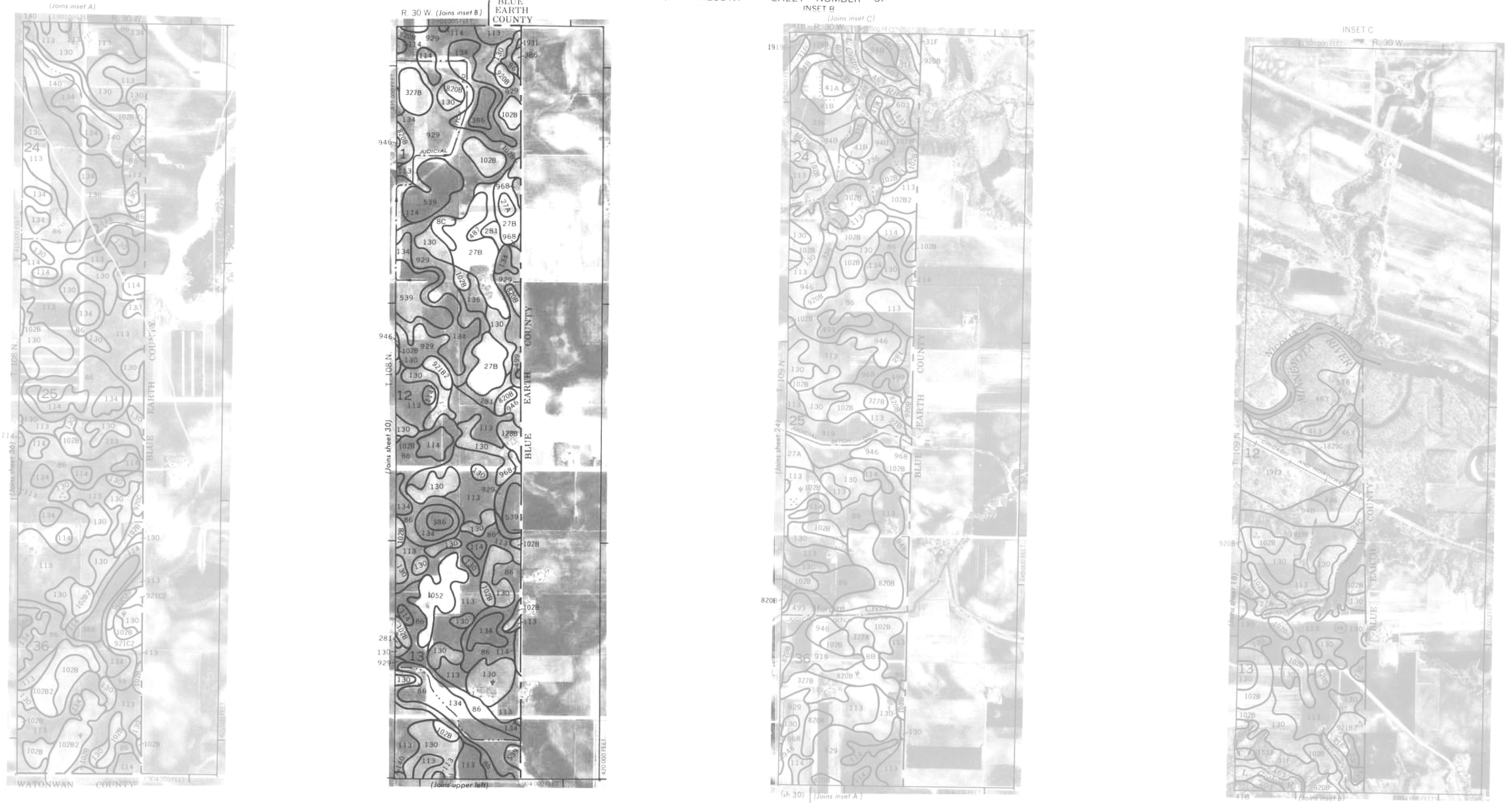


BROWN COUNTY, MINNESOTA — SHEET NUMBER 37

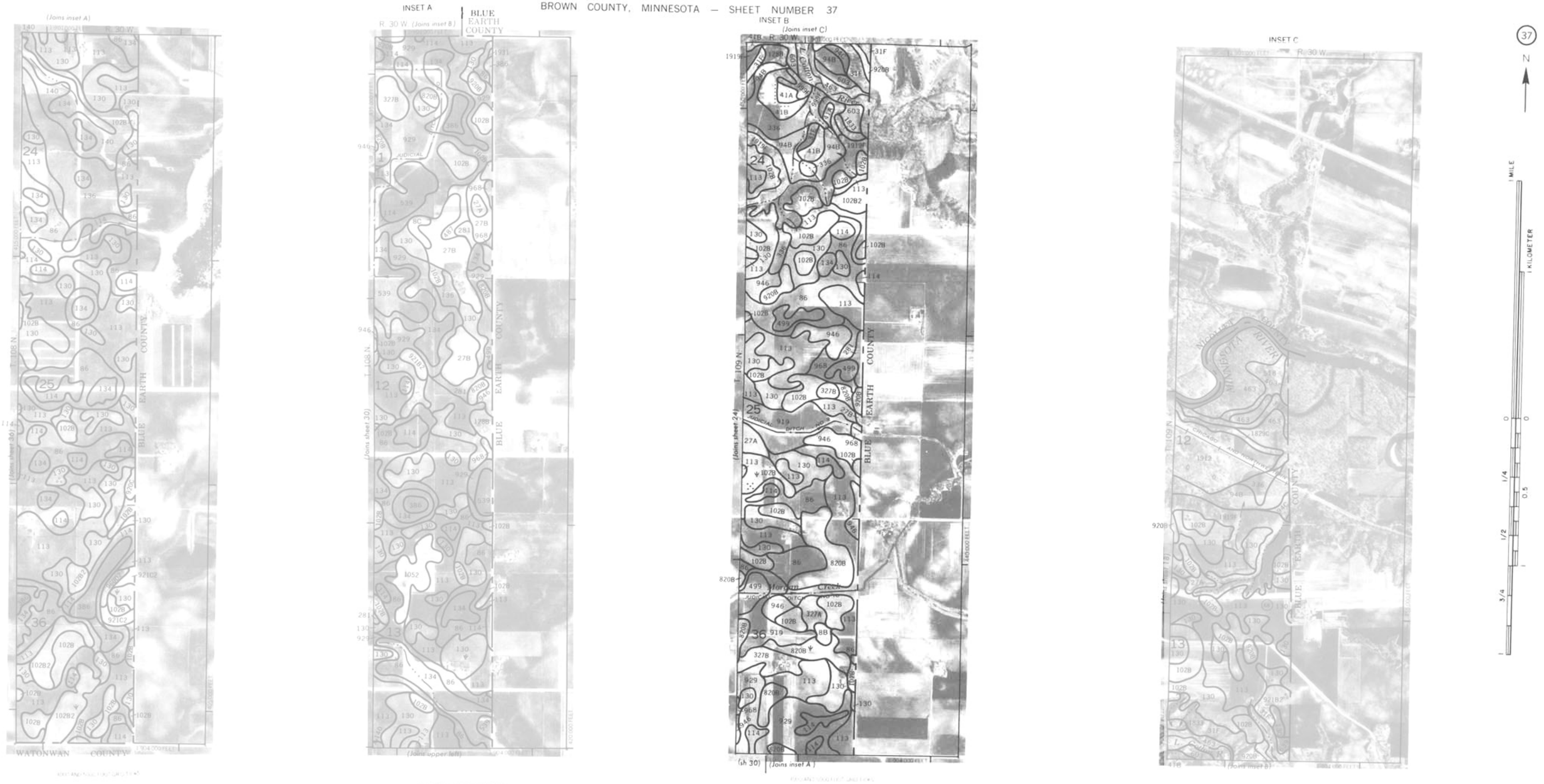
INSET A

INSET B

INSET C



BROWN COUNTY, MINNESOTA — SHEET NUMBER 37



BROWN COUNTY, MINNESOTA — SHEET NUMBER 37

INSET A

INSET B

INSET C